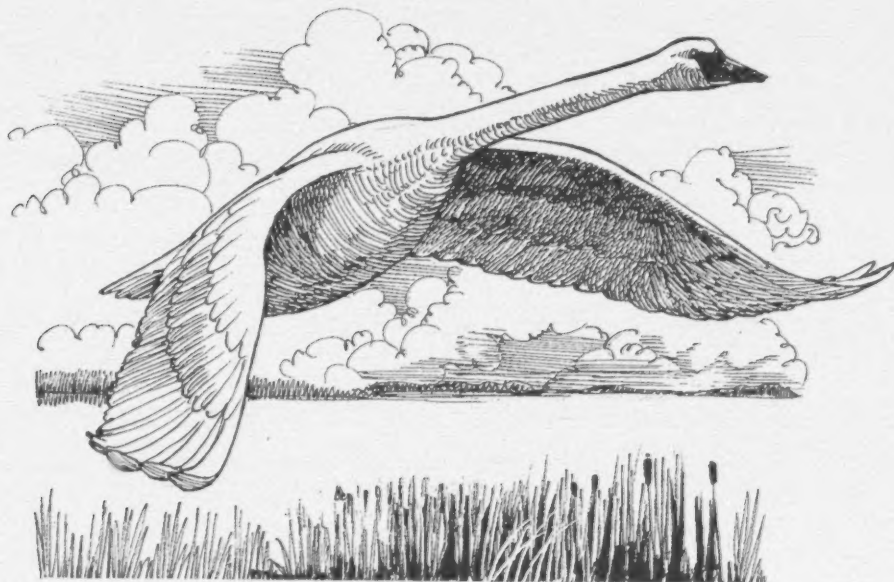


Status of the Trumpeter Swan (*Cygnus buccinator*) in Alberta:

Update 2013



Alberta Wildlife Status Report No. 26 (Update 2013)

Status of the Trumpeter Swan (*Cygnus buccinator*) in Alberta:

Update 2013

Prepared for:
Alberta Environment and Sustainable Resource Development (ESRD)
Alberta Conservation Association (ACA)

Update prepared by:
Paul A. Smith

Much of the original work contained in the report was prepared by M. Lynne James in 2000.

This report has been reviewed, revised, and edited prior to publication.

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PREFACE

Every five years, Alberta Environment and Sustainable Resource Development reviews the general status of wildlife species in Alberta. These overviews, which have been conducted in 1991 (*The Status of Alberta Wildlife*), 1996 (*The Status of Alberta Wildlife*), 2000 (*The General Status of Alberta Wild Species 2000*), 2005 (*The General Status of Alberta Wild Species 2005*), and 2010 (*The General Status of Alberta Wild Species 2010*), assign individual species "ranks" that reflect the perceived level of risk to populations that occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily available sources of population data. A key objective of these reviews is to identify species that may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the general status exercise, and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are *At Risk* or *May Be At Risk* in the province, that are of uncertain status (*Undetermined*), or that are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by Alberta Conservation Association and Alberta Environment and Sustainable Resource Development. They are intended to provide detailed and up-to-date information that will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information that will assist Alberta's Endangered Species Conservation Committee in identifying species that may be formally designated as *Endangered* or *Threatened* under Alberta's *Wildlife Act*. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

Trumpeter swans once ranged widely across North America. However, by the early 1900s, a combination of habitat destruction and hunting extirpated the species from much of its range. In recent decades, through active management and restoration efforts, trumpeter swan populations have regained some of their former abundance and distribution. The species is now considered to be *Not At Risk* by the Committee on the Status of Endangered Wildlife in Canada and *Not Listed* by the Endangered Species Program of the United States. In Alberta, the trumpeter swan remains listed as a *Threatened* species under the provincial *Wildlife Act*.

During the most recent comprehensive survey (2010), trumpeter swans were found to be widely distributed throughout several regions of Alberta. A majority of the provincial population is concentrated in the vicinity of Grande Prairie, but trumpeter swans are increasing in abundance and occupying new breeding lakes in areas including Peace River-High Level, Utikuma-Peerless, Cardston-Pincher Creek, Edson-Whitecourt, and Elk Island National Park. Trumpeter swans in Alberta now form a substantial (and increasing) fraction of the Rocky Mountain population (48.5%), and an important fraction of the species' global population (10.1%). Productivity, as measured by brood size and the number of cygnets in the post-breeding population, is higher in Alberta than in any other jurisdiction within the range of the Rocky Mountain population.

Trumpeter swans in Alberta have benefited from active management to reduce disturbance of their breeding lakes, as well as from land-use guidelines, reintroductions and other management activities that have contributed to the species' ongoing recovery. However, as population abundance increases, new challenges may emerge. Quantity and quality of staging habitat is important for survival and successful reproduction, but current use of staging habitats throughout the province is incompletely understood. Similarly, the current wintering range is incompletely known, and conditions during winter in the United States may significantly impact Alberta's trumpeter swans.

ACKNOWLEDGEMENTS

We thank Mark Heckbert (Alberta Environment and Sustainable Resource Development; ESRD) for assistance with accessing survey data, and Glenn Mack (Ducks Unlimited Canada; DUC) and Alain Richard (DUC) for provision of data from their surveys of swans and other waterfowl. We also thank Dr. Len Hills, Jerrod Looft, the Canadian Wildlife Service, Kimiwin Lake Naturalists, Jason Caswell (ESRD) and Ruth Shea for observations or contributions of unpublished data. Unpublished data from Parks Canada Agency and the Trumpeter Swan Society are also included in the report. Lonnie Bilyk (ESRD) assisted with preparation of FWMIS data, and Mike Ranger (Alberta Conservation Association) and Robin Gutsell (ESRD) assisted with contacting species experts. Brian Sullivan (Cornell Lab of Ornithology) assisted us in accessing eBird data. We thank Robin Gutsell, Mark Heckbert, Glenn Mack, Sue Peters (Alberta Conservation Association) and Dave Stepnisky (ESRD) for reviewing earlier drafts.

Preparation of this updated report was funded by Alberta Conservation Association and Alberta Environment and Sustainable Resource Development.

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INTRODUCTION

Trumpeter swans (*Cygnus buccinator*) were once widespread and abundant in North America. Although the exact historical distribution is unknown, the species may have bred from Alaska to California, and British Columbia to Newfoundland (Mitchell and Eicholz 2010). A combination of heavy hunting pressure and habitat loss drastically reduced the species' population, and by 1935 it was believed that only 69 individuals remained in a small area of Montana, Wyoming and Idaho. Although previously unknown flocks were later discovered in western Canada and Alaska, it was clear that the species' population size and distribution had been dramatically reduced. The species was protected from hunting by the signing of the *Migratory Birds Convention Act* in Canada in 1917 and the *Migratory Bird Treaty Act* in the United States in 1918. In addition, efforts were undertaken in both Canada and the United States to create and protect suitable nesting habitat, manage water levels in key wintering areas, and supplement population growth through reintroduction and translocation programs. These conservation efforts have been extremely successful, and almost all swan populations have increased in the last 50 years (McKelvey et al. 1985, Beyersbergen and Shandruk 1993, Subcommittee on the Interior population of Trumpeter Swans 1997, Groves 2012). Still, the trumpeter swan remains among the rarest waterfowl in North America.

In 1975, the continental population was approximately 5100 individuals with fewer than 200 known to breed in Canada (e.g., Moser 2006). The species was assessed as *Special Concern*¹ by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) in 1978, owing to a small population size. In April of 1996, with a population approaching

20 000 birds, the species was designated as *Not at Risk* in Canada. Ongoing monitoring efforts have documented substantial increases in both abundance and range since this time, so trumpeter swans are still considered *Not at Risk* in Canada (COSEWIC 2012). However, the trumpeter swan remains listed as a *Threatened* species in Alberta. This report summarizes current and historical information on the trumpeter swan, as a step in reviewing the species' status in the province.

SPECIES TAXONOMY

Three populations of trumpeter swans are recognized on the basis of their breeding ranges: the Rocky Mountain population (which occurs in Alberta and elsewhere), the Pacific Coast population, and the Interior population (Figure 1). Observations of banded individuals suggest some mixing among populations; however, there is genetic differentiation between the Pacific Coast and Rocky Mountain populations (Oyler-McCance et al. 2007). No subspecies are formally recognized. The current Interior population of trumpeter swans is largely the product of translocation efforts using eggs from the Pacific and Rocky Mountain populations. It is therefore not genetically distinct. The population within Alberta is assumed to be panmictic (potential for random breeding throughout entire population), but no studies of subpopulation structure have been undertaken.

The breeding range of trumpeter swans in Alaska overlaps with that of the more numerous tundra swan (*Cygnus columbianus*), although the latter species breeds primarily in more coastal and northern habitats. The degree of overlap is increasing and complicates aerial surveys (Conant et al. 2007). During migration and winter, trumpeter swans can often be found in mixed flocks with tundra swans and feral mute swans (*Cygnus olor*); some aerial surveys (e.g., in British Columbia) rely on ground counts to establish the proportion of each species found in mixed flocks. In captivity, all

¹ See Appendix 1 for definitions of selected status designations.

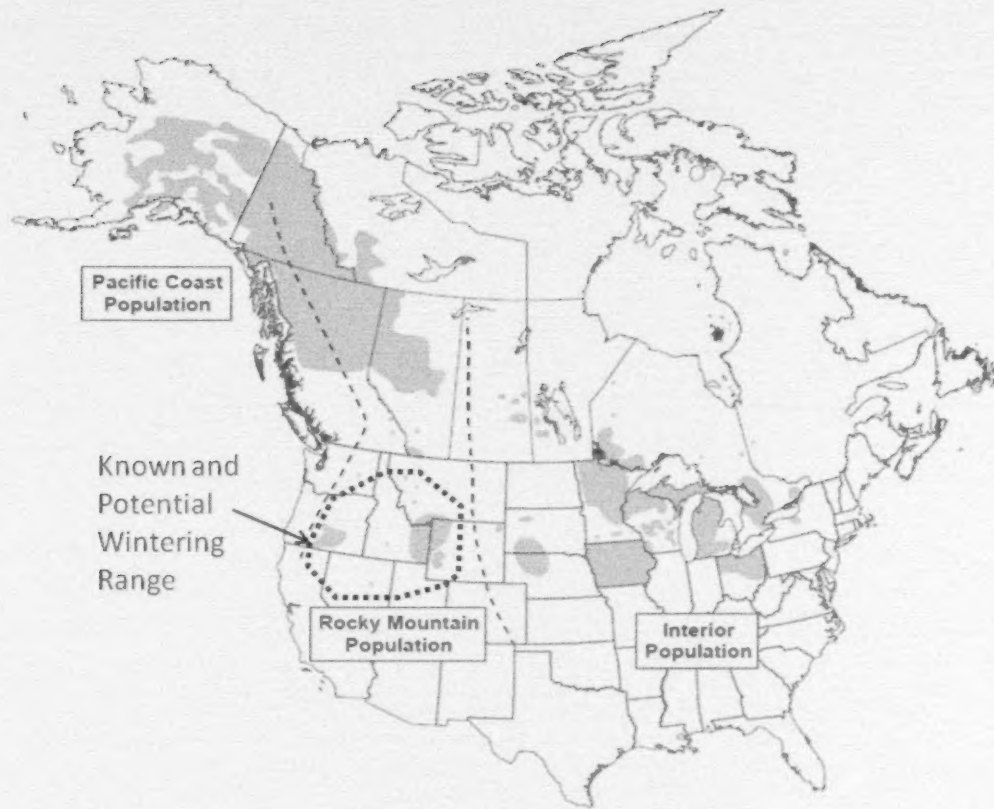


Figure 1. The North American range of trumpeter swans, and the known and potential wintering range for those swans breeding in Alberta (adapted from Groves 2012).

three species have been documented to produce fertile hybrids. Although hybridization is probably rare in the wild, the rapid expansion of mute swan populations in some portions of the trumpeter swan's range raises concerns both for competitive exclusion of trumpeter swans, and the potential for hybridization. This is primarily a concern for trumpeter swans of the Interior Population; however, a trumpeter swan paired with a mute swan has been observed during northward migration near Cochrane, Alberta (L. Hills pers. comm.; this observation is considered highly reliable in light of Dr. Hills' extensive experience with the species).

DISTRIBUTION

1. Alberta - Trumpeter swans are believed to have bred throughout Alberta historically

(James 2000), although exact breeding locations are unknown. Following the large decreases in abundance and range throughout the late 1800s and early 1900s, it was believed that all that remained of the Canadian population was a small flock breeding in the Grande Prairie area (Mackay 1981). In recent decades, the species has expanded its range (and abundance; see Population Size and Trends) in Alberta dramatically, from isolated breeding locations in past decades, to a widespread distribution currently (Figure 2). It now occurs widely throughout the province, but is most abundant in the vicinity of Grande Prairie (Central Mixedwood, Dry Mixedwood, Lower Foothills and Peace River Parkland natural subregions), in the lakes and marshes northwest of Slave and Utikuma lakes (Central Mixedwood and Lower Boreal Highlands natural subregions),

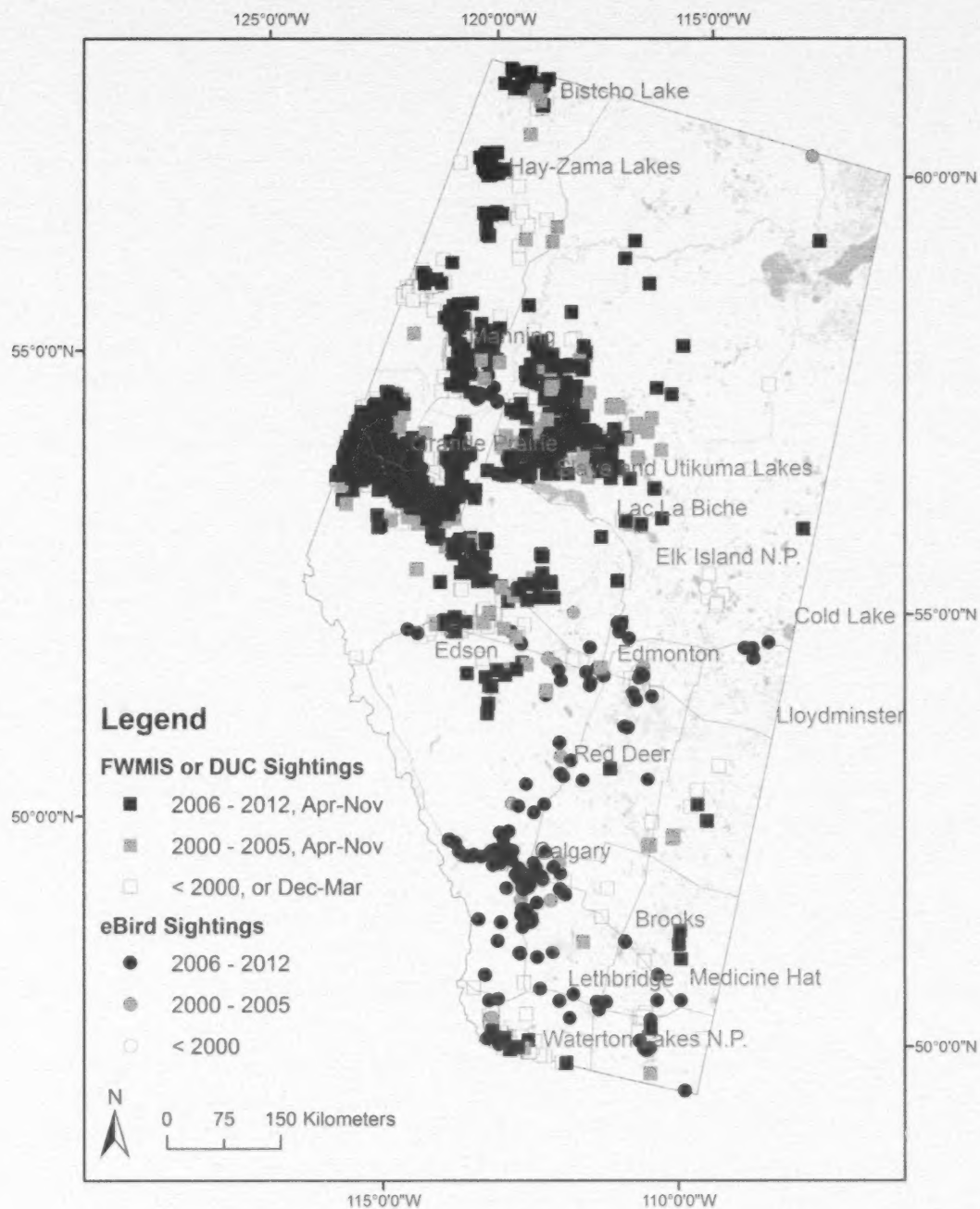


Figure 2. Sightings of trumpeter swans in Alberta in the Fisheries and Wildlife Management Information System (FWMIS) and Ducks Unlimited Canada (DUC) databases, separated by year-class: April–November, 2006–2012 (i.e., the most current sightings of potentially breeding swans; black squares); April–November, 2000–2005 (grey squares); and sightings prior to 2000 along with those from the non-breeding season in any year (hollow squares). Sightings contributed by naturalists to the eBird database (breeding and non-breeding seasons) are also presented, separated by years (eBird 2012).

and in the Lower Boreal Highlands west of Manning (Figure 2).

Trumpeter swans breed elsewhere in the province as well. Aggregations of breeding or potentially breeding individuals occur in the Hay-Zama Lakes area (Central Mixedwood Natural Subregion) and the Bistcho Lake area (Northern Mixedwood), Elk Island National Park (Dry Mixedwood) where a reintroduction program was initiated in 1987, and from Pincher Creek south to Waterton Lakes National Park and east (Foothills Parkland, Foothills Fescue). Trumpeter swans also breed near Edson (Lower Foothills), where they were first recorded in 1978 on Tie Camp Lake (Nordstrom 1984). Trumpeter swans have bred in the Lac La Biche area previously (James 2000), but recent observations of swans in this area during the breeding season are lacking despite the prevalence of much suitable habitat (M. Heckbert pers. comm.). These past and current aggregations of breeding individuals are divided into seven units for management purposes, known as: Grande Prairie-Valleyview, Peace River-High Level, Utikuma-Peerless, Cardston-Pincher Creek, Edson-Whitecourt, Elk Island and Lac La Biche (Alberta Trumpeter Swan Recovery Team 2006, Alberta Environment and Sustainable Resource Development [ESRD] 2013a).

All sources of monitoring information suggest a substantial increase in the range of the species within Alberta. Although the evidence for an increase is unequivocal, the exact extent of the increase is difficult to quantify since survey coverage has also increased over time. The range expansion has been tracked through successive provincial surveys since 1985 (Canadian Wildlife Service unpubl. data, James and James 2001, ESRD unpubl. data), but surveys were focused on areas where swans were known to occur and null values for areas where surveyors encountered no swans (for example, while conducting surveys for other taxa) have not been consistently recorded (D. Stepnisky

pers. comm.). The range expansion may be exaggerated to a small extent as a result of this expanding search effort in targeted surveys for the species (e.g., Fontaine and Heckbert 2010, Groves 2012). Also, the increasing trend for amateur naturalists to submit observations through channels such as eBird, and substantial recent efforts of conservation organizations such as Ducks Unlimited Canada (DUC) to survey the province's avifauna also expand the area surveyed for trumpeter swans. While this changing search effort complicates the calculation of exact figures for range expansion, all data indicate that this expansion of range has been large.

The most recent surveys of trumpeter swans in Alberta did not survey all known breeding areas, and mapping of suitable habitat has not been completed. It is therefore difficult to accurately quantify the proportion of the range within Alberta. In 2006, it was estimated that 20% of the North American range of trumpeter swans occurred within the province (Alberta Trumpeter Swan Recovery Team 2006). Surveys in the Lesser Slave Lake region in 2008 and the large-scale post-breeding surveys in 2010 documented a number of new confirmed or suspected breeding sites. Increases in estimated population size between the 2005 and 2010 surveys were much greater in Alberta than elsewhere in the range of the Rocky Mountain population, and among the largest increases for the species range-wide (Groves 2012). Thus, the fraction of the global range of trumpeter swans in Alberta may have increased since the previous estimate of 20%.

The extent of occurrence within the province, based on the minimum convex polygon of all documented sightings, is 615 936 km², or over 92% of the province's area. Restricting this assessment to sightings made only since 2000, during the breeding season (April–November), in provincial (FWMIS) and DUC databases yields an extent of occurrence of 560 865 km², or 84% of the province's area.

This metric includes large areas of unoccupied habitat because trumpeter swans are restricted to wetland habitats, as described in the Habitat section.

The area of occupancy of breeding habitat, calculated by summing the number of occupied 2-km x 2-km grid cells, is 4440 km² based on sightings made during the breeding season since 2000 in FWMIS and DUC databases. A more biologically-relevant measure of area of occupancy would be the combined area of occupied breeding lakes. The FWMIS includes 914 known breeding lakes/waterbodies with a total size of 1576 km². However, the area of small ponds and other difficult-to-map wetlands is underestimated in this total and, more importantly, the most recent large-scale surveys (i.e., 2010) for the species were not an exhaustive search; the full extent of potentially-suitable habitat has never been surveyed. For example, there is believed to be additional suitable but unoccupied habitat in northwestern and northeastern Alberta (M. Heckbert pers. comm). All recent surveys for the species have identified new breeding locations (e.g., Fontaine and Heckbert 2010, Groves 2012), so this 1576 km² estimate for area of occupied breeding lakes is undoubtedly an underestimate, and potentially by a large margin. This estimate also excludes staging habitat, which is believed to be important to the persistence of the species in the province, and might in fact be more limited in extent than breeding habitat. However, no extensive surveys of staging habitats have been carried out, so no estimate of area of occupancy of staging habitat is possible (but see eBird sightings in Fig. 3).

Owing to the large-scale, targeted surveys that occur at five-year intervals (e.g., Groves 2012), the population size of trumpeter swans is known with high confidence. Given this, proportions of the total population are more meaningful measures of jurisdictional responsibility than is the proportion of the species' range within

Alberta. During the 2010 survey of the trumpeter swan's entire North American range, 8.3% of all white (adult and subadult) swans were within Alberta, and 10.1% of all swans including cygnets. For the Rocky Mountain population, this represents 44.8% of all adults and subadults, and 48.5% of the total number of swans. This fraction in Alberta has increased over time; in 2005, it was estimated that 5.0% of the global population (including cygnets) occurred in Alberta, while in 2000, it was only 4.2% (Groves 2012).

The number of distinct locations where the species occurs is another parameter of conservation interest. Nesting waterbodies can be considered distinct locations for this purpose because they are affected by threatening events (e.g., disturbance effects) independently. A GIS model developed by the province in 2010 lists 914 discrete waterbodies where trumpeter swans are present (ESRD unpubl. data). However, as discussed above, given the incomplete survey coverage in 2010 and the ongoing increases in abundance and range, the current number of locations likely exceeds this number. Also, waterbodies used during the migration periods are under-represented in this database and their inclusion would further increase the number of locations. The number of locations (and their extent of occurrence) of trumpeter swans in Alberta has not likely undergone large fluctuations.

2. Other Areas - Historically, trumpeter swans bred across North America between Alaska and the Atlantic Coast, and as far south as Mississippi (Hansen 1973, Palmer 1976, Rogers and Hammer 1978, Mitchell 1994, Subcommittee on the Interior population of Trumpeter Swans 1997). Rogers and Hammer (1978) suggested that the species once wintered in at least a portion of all of the contiguous 48 states. By the early 1900s, heavy market and subsistence hunting coupled with the destruction of breeding and wintering habitat resulted in the extirpation of the trumpeter

swan from most of North America, leaving the species at the brink of extinction (Palmer 1976, Mitchell and Eicholz 2010). At that time, it was estimated that all of the remaining trumpeter swans occurred in the Tri-State area of northwest Wyoming, eastern Idaho, and southwest Montana (Banko 1960), and a small number in the Grande Prairie region of Alberta. The Pacific Coast population, which breeds in Alaska, British Columbia and the Yukon Territory, was not discovered until the early 1950s (Brechtel 1982).

All three populations of trumpeter swans have increased in range and abundance to varying degrees in recent decades. Swans of the Pacific Coast population currently breed widely throughout Alaska, the southwestern Yukon Territory and northwestern British Columbia. This population winters along the Pacific Coast from Alaska to Oregon (Hansen et al. 1971, Conant et al. 1984, Mitchell 1994, Mitchell and Eicholz 2010). Expanded search effort and real population increases have resulted in dramatic increases in the estimates of abundance and range for this population.

The Interior population of trumpeter swans may have numbered as few as 50 individuals in 1965 (Subcommittee on the Interior population of Trumpeter Swans 1997), but has increased exponentially in abundance in recent decades (see Population Size and Trends), and 2010 surveys documented a breeding range that includes Iowa, Manitoba, Michigan, Minnesota, Nebraska, New York, Oklahoma, Ontario, South Dakota, and Wisconsin (Groves 2012). Surveys in Wyoming counted only a single adult swan from the Interior population in 2010, none in 2005 and two adults in 2000 (Groves 2012, Moser 2006, and Caithamer 2001, respectively); thus, this state might not be included in this population's regular breeding range. Surveys were not carried out in Saskatchewan in 2010, but 2005 surveys in that province documented several breeding locations and counted 78 Interior population

trumpeter swans in total (Moser 2006). The Interior population winters primarily in Illinois, Iowa, Kansas, Michigan, Minnesota, Nebraska, Ohio, and South Dakota (Subcommittee on the Interior population of Trumpeter Swans 1997, Mitchell and Eicholz 2010).

The Rocky Mountain population is divided into two groups for management: the Canadian flock, including birds breeding in Alberta, British Columbia, the Northwest Territories and the Yukon Territory²; and the U.S.-breeding segment, consisting primarily of the Tri-State flock that breeds and winters in Montana, Wyoming and Idaho. Ongoing captive release programs and other restoration efforts have helped to establish Rocky Mountain population swans in other areas of the western United States, including Central Montana, Nevada, Oregon and Washington; these are referred to as the Restoration flocks. A majority of the birds from the Rocky Mountain population winter in the Tri-State area (Reiswig 1984), but swans from the Restoration flocks typically winter in areas near their breeding locations (Olson 2012).

Previously, summer abundance estimates for the entire Rocky Mountain population closely matched the estimates of wintering birds in the Tri-State area, suggesting that a vast majority of the Canadian flock wintered in this area. However, the estimate from the 2010 range-wide, post-breeding survey was more than 3700 swans larger than the estimate from mid-winter surveys in 2010–2011 (Olson 2012; 42% of the 2010 post-breeding population estimate), suggesting that a substantial portion of the Canadian flock was wintering outside of the surveyed portions of the Tri-State area.

² This range is typically described as including western Saskatchewan, but there are only 3 records in eBird (from Cypress Hills: 1980, 1982, 2010) and none of the recent (2000, 2005, 2010) range-wide surveys captured Rocky Mountain population swans in Saskatchewan (though search effort has been low to zero).

In light of this newly identified discrepancy, the exact wintering range of the Canadian flock of Rocky Mountain population trumpeter swans is unknown. Birds released in Elk Island National Park have been observed wintering in central Oregon at Summer Lake National Wildlife Refuge, Harney Lake National Wildlife Refuge, and the Sacramento Valley in northern California (Beyersbergen and Kaye 1995), so some portion of the Canadian flock may be wintering in these areas. Sladen and Whissel (2007) reported observations of neck-banded birds breeding in Alberta and wintering on Vancouver Island, British Columbia. Other marked, Canadian-breeding, Rocky Mountain population birds have been observed outside of the Tri-State area in Arizona, California, Colorado, Idaho, Oregon, Nevada, New Mexico, and Utah (Mitchell and Eicholz 2010). In the last decade, numbers lingering late or returning early to open water in the vicinity of Calgary (e.g., Glenmore Reservoir), High River (e.g., Frank Lake), and elsewhere in southern Alberta have increased. Although some of these birds overwinter where open water persists, the fraction of the Rocky Mountain population wintering in Canada is still very small.

HABITAT

1. Breeding Habitat - Trumpeter swans breed widely across North America and habitat use varies across this broad range. The species breeds in a variety of freshwater lakes, marshes, ponds and even rivers. Mitchell and Eicholz (2010) list the basic breeding habitat requirements as waterbodies with adequate room for takeoff (approximately 100 m), shallow depths with accessible submerged/emergent vegetation, stable levels of unpolluted fresh water, low human disturbance, and a muskrat (*Ondatra zibethicus*) house, island or other structure for the nest site.

In Alberta, trumpeter swan nesting sites typically share at least five common characteristics: 1) lake/pond water levels do

not have marked seasonal fluctuations, 2) the waters are quiet, without strong wave action or currents, 3) shallow water so the swans can dig for tubers and roots of aquatic plants, 4) isolation and security from human disturbance, and 5) areas of emergent vegetation (Banko 1960, Nordstrom 1984, James 2000). Nests are rarely located in upland areas but are usually located near shore, on small islands, muskrat or beaver lodges, beaver dams, floating mats of vegetation or man-made platforms (Hansen et al. 1971, Brechtel 1982, Mitchell and Eicholz 2010). When nests are located on islands, they are typically less than 200 m from shore (Hansen et al. 1971). Habitats supplying high abundance of aquatic invertebrates (Lockman et al. 1987) and/or aquatic plants (Squires 1991) have the greatest swan productivity.

Fontaine and Heckbert (2010) provided an account of trumpeter swan habitat use in the Lesser Slave Lake area, based on observations made during aerial surveys carried out in 2008. They noted that waterbodies with convoluted shorelines and abundant emergent and submerged vegetation seemed to be preferred, as did vegetated creeks and draws flooded by beavers. Ponds within bogs and fens appeared to be avoided as breeding habitat. Mitchell and Eicholz (2010) suggested a preference for large lakes. However, in Alberta, Fontaine and Heckbert (2010) found trumpeter swans to use lakes smaller than 10 acres (4 ha) when these were connected by small creeks to other waterbodies. As has been found elsewhere, they found that trumpeter swans typically avoided waterbodies with recreational or industrial shoreline development.

This sensitivity to disturbance and reliance on shallow wetlands with abundant aquatic vegetation means that breeding habitat for trumpeter swans is susceptible to degradation or loss as a result of resource development, agricultural activities and pollution (e.g., Schneider 2002, Slattery et al. 2011; see also Limiting Factors). In southern Alberta,

trumpeter swans may already occupy most of the suitable wetlands, and additional breeding habitat to support further increases in abundance may be limiting (ESRD 2013a). However, in northern Alberta, habitat availability does not appear to be limiting the population, as all seemingly suitable breeding habitat is not occupied. For example, in surveys of the Lesser Slave Lake region, Fontaine and Heckbert (2010) reported that the area between Utikuma and Muskwa lakes held fewer pairs than expected based on the apparent quality of the breeding habitat. Other experts have also commented on the availability of unoccupied, seemingly suitable breeding habitat in the northern portion of the province (Hawkings et al. 2002, G. Beyersbergen and M. Heckbert pers. comm. in Alberta Trumpeter Swan Recovery Team 2006). The issue of breeding habitat availability is explored more fully below (see Limiting Factors).

2. Migration and Staging Habitat - During migration, staging and moulting, trumpeter swans rely on a network of wetlands where foraging conditions are sufficient to support their high nutritional demands (LaMontagne et al. 2003a). Often these habitats include inlets or outlets, so that the ice-free season is lengthened (Mitchell and Eicholz 2010). There are a number of staging sites used throughout Alberta, but some key staging sites with large and regular numbers of swans include Bear, Buffalo, Clairmont, Cutbank, Gummer, Jones, LaGlance, Lowe, McNeil, Preston, Sinclair, Valhalla, Whitam and Wilkin lakes in the Grande Prairie Area, and East Cochrane Lake, Frank Lake, Jumpingpound wetlands, Pile of Bones Creek, Sibbald Flats and Sibbald Flat East ponds in the Calgary and High River areas (Alberta Trumpeter Swan Recovery Team 2006, ESRD 2013a).

Surveys in the Cochrane area record up to 600 trumpeter swans per day during the peak of the migration period (April 15th–27th; L. Hills unpubl. data). In the last decade, trumpeter

swans have shifted away from the small ponds they once used, where aquatic forage may have become depleted, and currently use shallow portions of Lac des Arcs and reservoirs along the Bow River (L. Hills pers. comm.). Northeast of Grande Prairie at Kimiwan Lake at McLennan, maximum daily counts of staging mixed flocks of tundra and trumpeter swans range between 8000–12 000 birds each fall. The total number of trumpeter swans has not been enumerated, but they are observed daily during the fall migration (Kimiwan Lake Naturalists unpubl. data).

Sightings contributed by naturalists to eBird demonstrate that there are numerous other wetlands throughout Alberta used by trumpeter swans during migration (eBird 2012; Figure 3). However, formal efforts to survey these habitats have not been extensive (ESRD 2013a). In most cases, the wetlands used by migrating birds are not used for breeding (Hills 1996a, 1996b).

3. Wintering Habitat - Many of Alberta's trumpeter swans winter in the United States in the Tri-State area, where the borders of Montana, Idaho and Wyoming meet (Shea 1979). Results of a satellite tracking study from 2002 and 2003, including data from 13 individuals breeding in the Yukon Territory and northwest British Columbia, also suggested the Tri-State area as the primary wintering location for this segment of the Canadian flock (Trumpeter Swan Society unpubl. data). Weather is the greatest single factor affecting winter distribution and survival in this area as temperatures can reach minus 45°C, and snow accumulations average 250 cm–380 cm (McEneaney 1984). Trumpeter swans survive in these harsh conditions because a combination of complex geological formations and weather patterns in the area create mild microclimates (McEneaney 1984). A midwinter thaw lasting one to two weeks occurs almost annually and opens up water that may otherwise have frozen (McEneaney 1984).

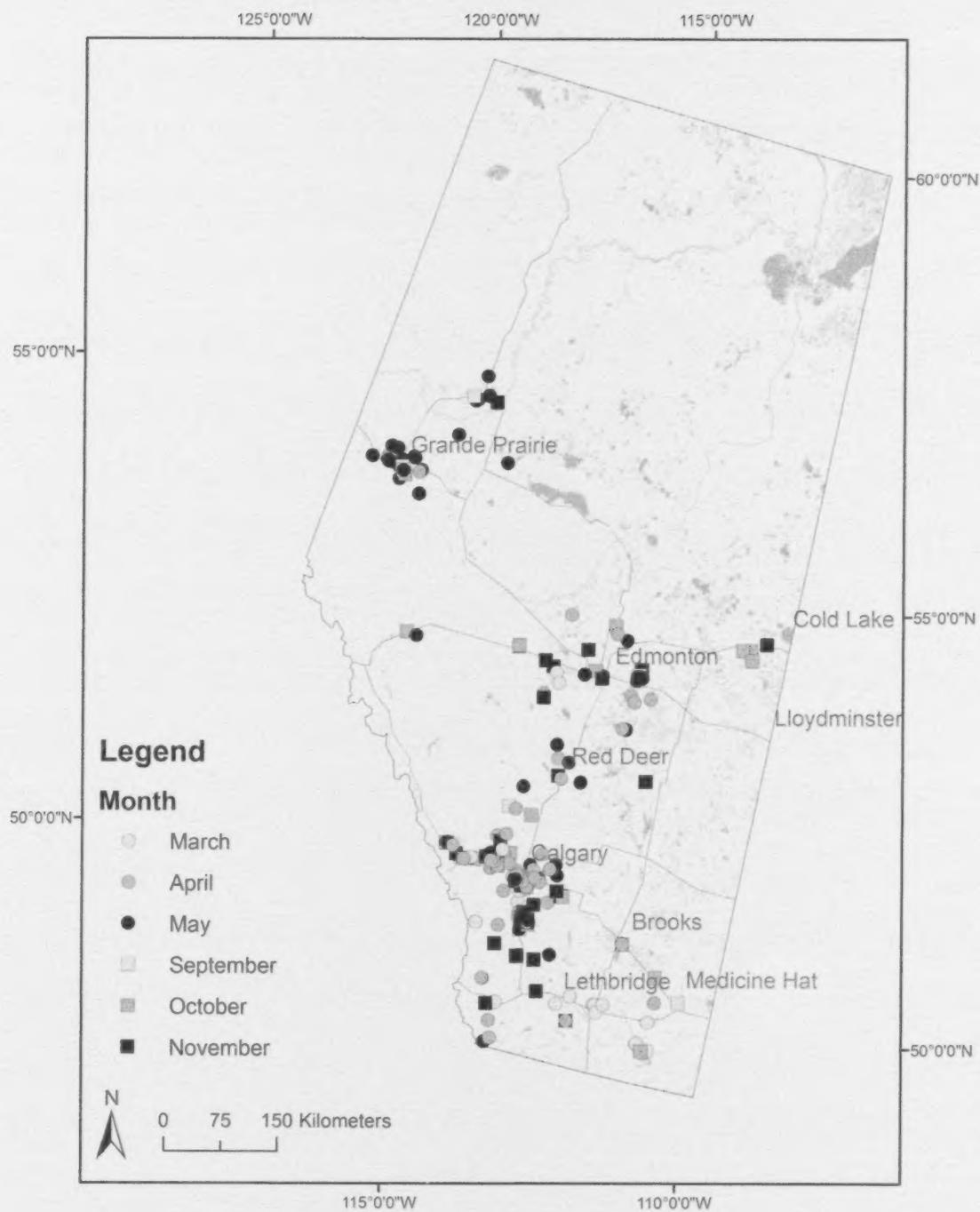


Figure 3. The distribution of trumpeter swans in Alberta during the spring and fall migration periods, based on sightings contributed by naturalists to the eBird database (eBird 2012).

The Tri-State region also has unique geothermal and hydrological features. There is a large system of open-water thermal basins, natural springs, ponds, lakes, and rivers that offer wintering habitat (McEneaney 1984). Trumpeter swans are not found directly adjacent to hot springs and geysers because few plants survive there, but are often found downstream, where the warm water mixes with cooler water (McEneaney 1984). Natural springs such as Big Springs, Idaho and Culver Springs, Montana also provide ideal winter habitat because these areas are shallow, slow moving, and free of ice.

As discussed above, it was previously believed that nearly all of Alberta's trumpeter swans wintered in the Tri-State area, especially along a 14-km stretch of the Snake River near Harriman State Park in Idaho (Reiswig 1984). However, current monitoring information suggests that perhaps 40% or more of Canadian breeding swans from the Rocky Mountain population are wintering elsewhere. Incomplete understanding of winter distribution for Alberta's trumpeter swans is an important information gap, because habitat limitation in a restricted wintering range in the Tri-State area was believed to be a significant factor limiting the population at the time of the last status assessment (James 2000).

Sightings of small numbers of wintering swans are becoming increasingly common at a large number of locations throughout the western United States, including portions of Idaho, Montana, and Wyoming away from the core Tri-State area, and locations in Colorado, Nevada, Oregon, Utah, and elsewhere. Indeed, wintering trumpeter swans can now be seen almost anywhere in the continental United States, reflecting the broad, historical wintering range (Mitchell and Eicholz 2010).

Ideal winter habitat is described by Lockman et al. (1987) and Mitchell and Eicholz (2010) as areas with the following characteristics: open water more than 100 m in length or

width; stream channels wider than 15 m; water velocity less than 45 cm/s; banks with little or no shrub cover; water depth greater than 0.6 m and less than 1.3 m for foraging; water deeper than 10 cm and/or sand/gravel bars for loafing and roosting; bank slopes that are not steep (<50% grade); soft substrates greater than 5 cm deep; abundant, diverse aquatic vegetation; more than 75% open water in winter; water freezing only intermittently and for fewer than two consecutive days; no wire fences or power lines crossing habitat or flight paths; free from pollution, and little or no human disturbance.

Winter foraging behavior, and thus habitat use, may be changing. In recent years, trumpeter swans have shifted their winter feeding patterns in eastern Idaho, taking advantage of waste field potatoes and grain (ESRD 2013a). This change may reflect learned behaviour as well as an increasing frequency of mild winters on the winter range. These new food sources could contribute to an improved winter body condition, and might play a role in the population increases observed on the breeding grounds.

CONSERVATION BIOLOGY

1. Identification - The trumpeter swan is North America's largest native waterfowl, with males weighing approximately 12 kg and females weighing 10 kg (Hansen et al. 1971, Barrett and Vyse 1982, Drewien and Bouffard 1994). They are completely white except for their black bills and legs, and are easily mistaken for the slightly smaller and more abundant tundra swan. Subtle morphological differences exist between the species (for example, most tundra swans have a yellow spot in front of the eye), but they are best distinguished by voice; trumpeter swans have a deep trumpet-like call, whereas tundra swans have a high-pitched "bark" (Munro 1962, Palmer 1976, Drewien and Bouffard 1994).

2. Breeding - Trumpeter swans wintering in the Tri-State area depart for their breeding grounds in Canada between 1 March and 1 April (Mitchell and Eicholz 2010). The initial pair bonds are formed from late March to mid-May (Lockman et al. 1987). Trumpeter swans pair with life-long mates as early as their second winter, and most swans are paired by the end of their third winter (Palmer 1976, Brechtel 1982). Despite this early pairing, the average age of first reproduction by trumpeter swans in Alberta is five years (Brechtel 1982). The age of first breeding for the species in general is reported as at four to seven years of age (Banko 1960, Gale et al. 1987, Wilmore 1979), although it has been reported to occur rarely as early as at two or three years of age (Monnie 1966, L. Hartman and M. Mossman pers. comm. in Mitchell 1994).

Trumpeter Swans arrive in Alberta in early April to early May (Pinel et al. 1991). Nest building occurs between late April and early May, and because the species is highly territorial, breeding density is generally one pair per lake or pond (Brechtel 1982, Mitchell 1994). Nests are typically used for many years and take several days to two weeks to build (Palmer 1976, Brechtel 1982, Grant 1991). A typical trumpeter swan nest is approximately 1.8 m–3.6 m in diameter, less than 0.5 m high, composed of vegetation such as cattails (*Typha latifolia*), bulrushes (*Scirpus* spp.) and horsetails (*Equisetum* spp.), and lined with down (Brechtel 1982, Grant 1991). The adults may remove vegetation from around the nest to provide good visibility and protection from predators (Brechtel 1982, Mitchell 1994).

Clutch size ranges widely, up to 11 eggs in captivity, but usually between 4 and 6 eggs in the wild (Mitchell and Eicholz 2010). A clutch of six eggs represents approximately 20% of the female's mass (Lumsden 2002), and there is some suggestion that clutch size may be influenced by the nutritional condition of the female (Mitchell and Eicholz 2010).

Pairs are not known to re-nest in the wild when clutches are lost (Mitchell and Eicholz 2010). Incubation lasts from 32 to 37 days and is shared unequally, with the female responsible for most of the incubation duties (67%–96%; Mitchell and Eicholz 2010 and references therein).

Hatching success for trumpeter swans ranges from 50% to 90% (Burgess 1972). In the Grande Prairie area, hatching success averaged 77.2%, with an average brood size of 3.34 cygnets (James 2000). At this location, the mean number of young reared to fledging per breeding female has been estimated at 2.01 (SD = 0.166, n = 545; G. Beyersbergen pers. comm. in Mitchell and Eicholz 2010). During the range-wide post-breeding surveys in 2010, both the estimated number of cygnets (1838, or 39% of the population) and the mean brood size (3.7) were higher in Alberta than any other region in the Rocky Mountain population (overall, cygnets composed 34% of total Rocky Mountain population and mean brood size was 3.4; area-weighted mean, no SE reported; Groves 2012).

Nests and cygnets are susceptible to a variety of larger avian and mammalian predators, but adults' large size and aggressive nest defence mean that predation of eggs and young is lower for trumpeter swans than for many avian species (Brechtel 1982, ESRD 2013a). Infertility, embryonic death and nest abandonment also account for a substantial fraction of failed reproductive attempts: 9%–29% of unhatched eggs (Hansen et al. 1971, Gale et al. 1987). Incubation constancy of the female is positively related to the number of cygnets hatched and fledged, and females take shorter recesses in higher quality habitats (Shea 1979, Henson and Cooper 1993, Bollinger and King 2002).

In Alberta, hatching occurs in late May through June and rarely into July (ESRD 2013a). Once cygnets hatch, the adults are rarely more than 20 m apart and cygnets are usually 5 m–10 m from one or both parents (Grant 1991).

Cygnets feed almost exclusively on aquatic invertebrates and crustaceans for the first two to five weeks after hatching (Banko 1960, Hansen et al. 1971, Page 1976). By the age of two to three months, however, a cygnet's diet is the same as an adult's, and consists of stems, roots and shoots of horsetail, pondweed (*Potamogeton* spp.), sedges (*Carex* spp.), and other plant material (Holton 1982, Grant 1991). Both adults and cygnets spend most of their time feeding in emergent vegetation, and adults may eat up to 9 kg of food per day (Holton 1982). This substantial food requirement may explain the territorial behaviour that typically results in a single swan family per lake (Brechtel 1982).

3. Fledging and Staging - Growth of cygnets is rapid and by 13–15 weeks most have had their first flight (Shea 1979, Brechtel 1982). Full fledging occurs between 84 and 122 days (typically 99–102 days; Mitchell and Eicholz 2010). In mid-September, trumpeter swans stage on larger lakes before migrating to wintering areas. In Alberta, most swans begin to migrate south by mid-October (Semenchuk 1992). However, numbers lingering into November and later in the vicinity of Calgary and High River may be increasing (see Figure 3).

4. Survival and Mortality - Mortality for trumpeter swans is highest during the first year of life. Survival of cygnets during the pre-flight period has been reported at 45%–78% (Banko 1960, Brechtel 1982, Lockman et al. 1987, Bart et al. 1991). In the Cochrane area, observations of southbound migrants suggest that there are at least four pairs without cygnets for every pair with cygnets (L. Hills unpubl. data). In the Grande Prairie area, survival from fledging to one year was reported at 42.9%, with most of the mortality occurring during late winter and the spring migration (Turner and Mackay 1981).

Around Grand Prairie, survival from one to two years was 70.9%, and from two to three years,

82.4% (Turner and Mackay 1981). Elsewhere, annual survival for birds over two years of age has been reported as between 76.5% and 100% (Anderson et al. 1986, Lockman et al. 1987, Lockman 1990, Bart et al. 1991). More recently, survival for migrating individuals of the Interior population was found to be high for both adults and sub-adults (82%–86%, with no evidence for lower survival of sub-adults; Varner and Eicholz 2011). Current estimates of adult survival for trumpeter swans breeding in Alberta are lacking. Maximum life span in captivity is 32.5 years (Kortright 1943). Wild trumpeter swans over 24 years old have been recaptured (Kennard 1975).

Natural causes of mortality include disease, parasites, exposure or starvation during severe winter weather, and predation (see Mitchell and Eicholz 2010). Predation is not considered to be a major source of mortality (Brechtel 1982). Winter mortality is common and can be severe (e.g., Whitman and Mitchell 2004). Heavy parasite burdens may also have significant population level impacts; Drewien and Bouffard (1994) found nasal leeches on 12% of trumpeter swans wintering in the Tri-State area. Leeches can be a direct cause of death among cygnets and can weaken adults, increasing their susceptibility to severe winter weather. However, the total contribution of disease and parasites to swan mortality is difficult to quantify (Mitchell and Eicholz 2010). A number of anthropogenic influences also contribute to mortality, and are discussed in the Limiting Factors section.

POPULATION SIZE AND TRENDS

1. Alberta - At the turn of the 20th century, it was believed that fewer than 100 trumpeter swans remained in Alberta (Mackay 1978). The first aerial survey of the breeding areas near Grande Prairie, at the time holding most of the province's trumpeter swans, was conducted in the fall of 1954 and counted 232 individuals (Mackay 1981). In 2010, the total number in

the province ($\pm 95\%$ confidence interval [CI]) was estimated at 2829 ± 390 adults/subadults, or 4667 ± 794 including cygnets. Survey coverage was expanded over time, in an effort to track the expanding population. These changes introduce some uncertainty in the precise estimates of percent change over time, but do not detract from the clear indication of an increasing trend in abundance and distribution.

Surveys separate "white swans" (one year of age and older) from cygnets, but because trumpeter swans can typically take four to seven years before breeding, the count of white swans may contain many reproductively immature individuals as well as non-breeding pairs. The number of white swans that are reproductively mature (assumed here to mean four years of age and older) can be estimated using a life table and survival rates from Alberta and elsewhere. This analysis indicates that approximately 61% of white swans are likely to be mature individuals. Applying this proportion to the provincial population estimate (2829 ± 390 adults/subadults) results in a provincial estimate of over 1700 mature individuals, with a likely range of approximately 1500–2000 swans. This is believed to be the most reliable method of estimating the number of mature trumpeter swans in Alberta, even though there are other possible methods (as outlined below).

A review of demographic rates across swan species (Bart et al. 1991) has shown that, as with other swan species, not all reproductively mature trumpeter swans breed in a given year. Surveys during the nesting season would resolve the number of breeding pairs in the province, but in the absence of such data, the number can be estimated using demographic information from elsewhere or from the number of broods counted during the survey. The proportion of breeding individuals in trumpeter swan populations has been estimated for Montana and Alaska as between 20% and 30% of the total number of adults (Bart et al. 1991). Surveys of a random sample of breeding locations in 2010

counted 1792 white swans (ESRD 2013a) and, extrapolated across the sampling frame³, these yielded a population estimate of 2829 ± 390 (Canadian Wildlife Service unpubl. data). The survey's estimate and the 20%–30% range yield an estimate of 566–849 breeding trumpeter swans in Alberta, with a 95% confidence interval of 488–966. Because survey data suggest atypically high rates of reproduction among Alberta's trumpeter swans (see below, this section), the 20%–30% estimate of the proportion of breeding individuals in the adult population may be low.

Brood counts offer another indication of the size of the breeding population, and may be more reliable in this instance. Surveys in 2010 counted 279 broods (ESRD 2013a), and mean brood size and estimated numbers of cygnets (Canadian Wildlife Service unpubl. data) yield an estimate of 496 (95% CI: 367–626) broods present within the sampling frame. Because each brood is tended by two breeding individuals, this yields a conservative estimate of 558 breeding adults based only on broods directly observed, and a more likely value of 993 (95% CI: 734–1253) based on the survey's estimates. The brood count approach will underestimate breeding population size, since the surveys (carried out after successful nests have hatched) can't identify breeding birds with failed nests or depredated broods at the time of surveys. If hatching success is 77% (as observed at Grande Prairie; James 2000), and the brood counts are corrected for the nests lost prior to hatching, the estimate for the number of breeding adults in Alberta becomes 1290 (95% CI: 953–1627). An additional 22%–

³ Sampling frame refers to the area from within which the 2010 survey locations were randomly drawn. This is the area over which results are extrapolated to produce the estimates. The sampling frame was defined by delineating areas within 20 km of sightings in the 2005 surveys. Thus, trumpeter swans in areas more than 20 km from 2005 locations would have been missed.

55% of cygnets may die during the pre-flight period (see Survival and Mortality, above). A conservative estimate of 10% mortality at the time of surveys (which occur before the pre-flight period is finished) would mean that the estimated breeding population was in fact 1433 adults (95% CI: 1059–1808), but the fraction dead at the time of surveys is unknown.

Thus, the possible range of values for the number of breeding trumpeter swans in Alberta is large. The absolute minimum number, based on direct observations of adults tending live cygnets part-way through the pre-fledging period (i.e., not extrapolated across the 2010 sampling frame, nor corrected for nests or broods lost prior to surveys), is 558 adults. The true value for the number of adults that initiated nests throughout the province in 2010 is more likely to be above 1000.

Surveys of wintering birds in 2012 suggest that the Canadian flock, including birds breeding in Alberta, has increased in abundance further since 2010 (Olson 2012). Between winter 2010–2011 and 2011–2012, counts of Canadian flock trumpeter swans wintering in the Tri-State area increased in abundance by 12%. The long-term rate of population growth for the Canadian flock derived from the post-breeding surveys, 1968–2010, is similar: 11.6% annually. Applying this rate of increase to extrapolate the 2010 survey results from Alberta to 2012 would suggest a post-breeding population size of more than 5800 swans (Figure 4), more than 3520 for white birds (adults/subadults) only, or more than 2000 mature individuals (assumed to mean four years of age and older). This possible 25% increase between 2010 and 2012 could be used to generate hypothetical estimates of the current breeding population based on the discussion presented above.

For assessment of a species' status, the trend over three generations is of interest. Trumpeter swans are a long-lived species that reproduces multiple times, but how their fecundity changes

with age is unknown; therefore, generation time (the average age of parents of the current cohort) must be approximated. Using the demographic rates (adult survival, age at first breeding and fecundity) reported above, generation time is on the order of 10 years (likely between 9 and 11 years). The trend in Alberta over the last three generations (i.e., 30 years) is best approximated using the range-wide post-breeding census data, available in a consistent form for 1985–2010 (Figure 4). Over this period, the log-linear line of best fit indicates an annual rate of population increase of 10.1% (a nearly 18-fold increase in abundance over 30 years). Figure 4 also shows that there have not been extreme fluctuations in the population measured at 5-year intervals between 1985 and 2010.

For 2000 and 2010, the most recent 10-year period for which trends can be calculated, population growth was 16.7% per year. This rate exceeds that in most other jurisdictions, and the proportion of the global population within Alberta has therefore increased over time, from 4.2% of the total including cygnets in 2000 to 10.1% in 2010.

These estimated rates of population increase are all extremely large and may be exaggerated to some extent by the expanding search effort over time. In particular, the 170% increase in survey counts between the 2005 post-breeding "census" and the 2010 "survey" likely reflects, in part, the shift in survey methods. The post-breeding surveys carried out in 2005 and earlier were intended to be a complete census of all swan breeding areas, although undoubtedly some breeding locations were missed. The 2010 surveys marked the first effort to employ a stratified-random sampling plan to survey swans in Alberta. The sampling frame included all locations known to hold swans (based on previous surveys), plus a buffer of 20 km. A sample of survey locations was drawn randomly from within this area (Figure 5), and population estimates were calculated to reflect the complete extent of this sampling

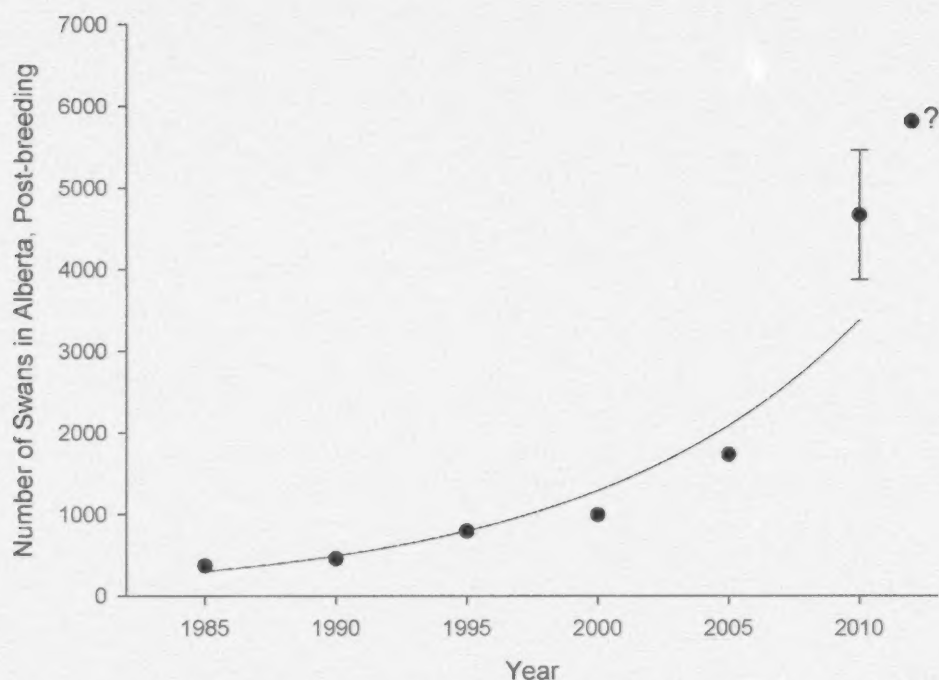


Figure 4. The estimated number of trumpeter swans in Alberta, based on the post-breeding surveys carried out at five-year intervals. Surveys in 2010 used a stratified-random sampling plan and the estimate is therefore displayed \pm SE; previous values were believed to be complete counts and therefore have no estimate of error. The log-linear line of best fit for 1985–2010 is displayed. The value presented for 2012 is hypothetical, based on the previously observed rate of population growth.

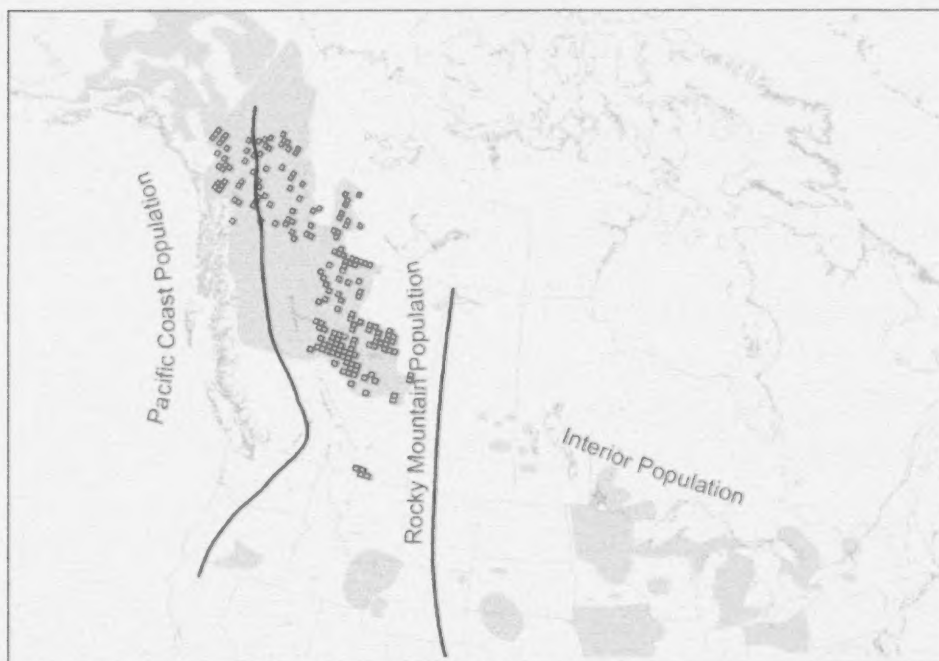


Figure 5. The distribution of areas surveyed (1:50 000 scale topographic map units, marked with black boxes) for Rocky Mountain population trumpeter swans during the 2010 range-wide surveys (from D.J. Groves in CWS Waterfowl Committee 2011).

frame. This method allowed for surveys to produce estimates for a larger area, albeit based on a statistical sample, than had been covered before. This expanded coverage likely contributed, in part, to the increase in survey counts between 2005 and 2010.

Regardless of changes in survey effort and methodology, the increases in abundance and range in Alberta are substantial, including expansion into new areas in some portions of the province and infilling within the previous range in others. In the Lesser Slave Lake region, for example, both abundance and range have increased; surveys in 2008 documented 195 swans in comparison to 77 in 2000, and identified 13 new breeding lakes (uncorrected for changes in search effort). Breeding numbers in and around Elk Island National Park have increased since the initial reintroduction attempts in 1987, and surveys in 2009 counted at least 34 birds returning to the area with more than half settling outside of the park's boundaries (Parks Canada unpubl. data). The 2010 post-breeding surveys documented a substantial number of swans in the Bistcho Lake area and numerous new breeding locations in the Edson-Whitcourt area. However, a majority of the population still breeds in the Grande Prairie area.

These increases in population size are supported by atypically high productivity among trumpeter swans breeding in Alberta. Mean brood size and the proportion of cygnets observed during the 2010 post-breeding surveys were higher for Canadian Rocky Mountain population trumpeter swans than any other segment of the species' global population (Groves 2012), and reproductive rates in Alberta were the highest of any Canadian jurisdiction. However, mean brood size in the Lesser Slave Lake region declined from 4.63 to 3.33 between 2000 and 2008 (Fontaine and Heckbert 2010), and counts of cygnets in the Tri-State area in the winter of 2011–2012 were 22% below those from 2010–2011, and below the 1974–2011

average (Olson 2012). Although metrics of reproductive success in some regions may have decreased in recent years, they remain high in comparison to elsewhere in the species' range, and high enough to support population growth.

2. Other Areas - The trumpeter swan has responded well to conservation efforts and reintroduction programs throughout its range, and all three North American populations have increased substantially in abundance in recent decades. The range-wide surveys during the post-breeding season of 2010 recorded 46 225 swans. This is a record high value since the surveys began in 1968, a 33% increase over the value recorded in 2005, and indicative of an average annual rate of population growth of more than 6% over the 42 years of surveys. This dramatic rate of population growth maintained over a period of decades makes the recovery of trumpeter swans one of North America's greatest conservation success stories.

The largest of the three populations, the Pacific Coast population was estimated (\pm SE) at $26\,790 \pm 1060$ in 2010, for an average annual growth rate of 5.5% since 1968 (Groves 2012). A majority of this population breeds in Alaska ($25\,347 \pm 1010$, or 95% of the population), but the numbers breeding in British Columbia and the Yukon Territory (1443 ± 323) have also increased over time and were 17% higher in 2010 versus 2005 (Groves 2012). These 2010 estimates may in fact underestimate the current population size, since the area surveyed in 2010 was the same as that surveyed in 2005 and potentially suitable habitat exists outside of surveyed areas. Regardless, the 2010 estimate exceeded the abundance objective for this population of "not less than 25 000 swans" (Pacific Flyway Council 2006) for the first time.

The Rocky Mountain population was estimated at 9626 ± 500 in 2010, suggesting an average annual growth rate of 6.3% since 1968. Of these, 8950 ± 500 , or 93%, were within

Canada, where counts throughout the range are increasing to varying extents. Alberta showed the largest increases between 2005 and 2010 (more than doubling the population estimate), presumably owing in part to the changes in survey methodology. Increases in British Columbia and the Northwest Territories were also substantial (92% and 86% increases, respectively), while increases in the Yukon Territory were more modest (17%; Canadian Wildlife Service unpubl. data). The remainder of the Rocky Mountain population breeding in the Tri-State area has experienced modest growth in recent years, and populations from other U.S. flocks (including Restoration Flocks) have more than doubled in abundance between 2005 and 2010, in part owing to the release of captive-reared birds (Groves 2012). These U.S.-breeding birds have yet to achieve their productivity and abundance objectives, but the Canadian flock exceeds the general management target for the Rocky Mountain population of "5% average annual growth in numbers of wintering birds" (Subcommittee on Rocky Mountain Trumpeter Swans 2008).

Once extirpated, the Interior population of trumpeter swans has increased dramatically in abundance in the last 50 years. Reintroduction programs and winter feeding programs have taken swan numbers from fewer than 50 individuals in 1965 (Subcommittee on the Interior population of Trumpeter Swans 1997) to 9809 swans in 2010 (Groves 2012). The estimated rate of annual population growth since 1968 is 13.0%, and the 2010 estimate was 111% higher than that of 2005. Pioneering flocks continue to establish new breeding locations, expanding the range in all directions. This population occurs in Manitoba and Saskatchewan, but only a small fraction of the known and potential range was surveyed in 2010, so that the current range and abundance in these provinces is unknown. The management objectives for this population of "at least 2000 birds and 180 successful breeding pairs by 2001" were reached by the time of the 2000

post-breeding survey (Caithamer 2001). As a result, captive release programs have been discontinued (Groves 2012).

3. Rescue Potential - For population rescue to occur individuals must be able to disperse into Alberta from other jurisdictions and survive in the province to reproduce; this requires the presence of healthy populations outside Alberta, the ability of individuals to move between jurisdictions, the ability of any immigrants to survive in Alberta habitat and the presence of sufficient habitat available to immigrants (IUCN 2003). In the case of trumpeter swans, there are populations in adjacent jurisdictions that could act as a source for rescue; the Rocky Mountain population extends into British Columbia, the Northwest Territories and the Yukon (Figure 1). Successful translocations across the continent (e.g., Beyersbergen and Kaye 1995, 2007, Groves 2012, Monnie 1966) suggest that trumpeter swans are able to survive in the variety of conditions encountered throughout their broad range. Finally, there appears to be suitable, unoccupied habitat in northern Alberta that immigrant swans could occupy (M. Heckbert pers. comm.).

Despite this species' general mobility and evidence of occasional mixing among North American populations (see Species Taxonomy section), trumpeter swans do not appear to have naturally recolonized suitable habitat in Alberta over long distances. There has been infilling of areas around those already occupied; however, most pioneering that has been observed into new habitat has occurred at very low expansion rates—typically up to 100 km in a decade (e.g., around Grande Prairie; M. Heckbert pers. comm.). It should be noted, though, that current surveys are not designed to thoroughly examine habitat in which swans have not been observed to date. Areas of habitat that are contiguous to occupied habitat could see recolonization from adjacent populations, but immigrants are less likely to come from jurisdictions outside of Alberta. Natural recolonization of areas that

are separated from currently-occupied habitat is likely to take decades. Enhancement of natural recolonization rate, if desired, would require direct management action, such as was enacted during the transplant program at Elk Island National Park.

In summary, rescue of Alberta populations is possible, and could be considered likely over the long term, but would be expected to take generations of swans, and there might be some areas that natural immigrants do not reach.

LIMITING FACTORS

1. Loss of Breeding or Staging Habitat -

Trumpeter swans require wetlands with abundant aquatic forage and minimal disturbance. Loss or degradation of these habitats could limit populations in some regions. For example, in the Parkland Natural Region, a significant amount of wetland habitat has been lost through drainage and water manipulation projects to accommodate an increase in agriculture, industrial development, and urbanization (Shandruk 1984, ESRD 2013a). Permanent loss of emergent vegetation and development along shorelines of some lakes near Grande Prairie has reduced habitat suitability and may have resulted in decreased breeding success (Holton 1982). Deteriorating water quality and intensive grazing of shorelines at key staging sites in the Jumpingpound Creek area, currently used by 1000–1500 swans in spring (L. Hills pers. comm. in JCWP 2009), may limit the suitability of this area in the future. Staging sites such as the Jumpingpound Creek area are critical in that they offer females the ability to maintain or build the nutritional reserves that support subsequent breeding (LaMontagne et al. 2004).

The continued increase in the population's abundance and range in Alberta, along with observations of apparently suitable unoccupied breeding habitat (Holton 1982, Fontaine and Heckbert 2010) suggest that availability of

habitat is in general not limiting population growth. However, habitat availability may influence populations in the future, particularly in more heavily-impacted portions of the province. In particular, it will be important to maintain the habitat quantity and quality at the restricted network of migratory staging sites for trumpeter swans.

2. Disturbance of Breeding Habitat -

Trumpeter swans are generally recognized as intolerant of disturbance, but few studies have been carried out to document the effects of disturbance on breeding and behaviour. A recent study in Alberta found no correlation between landscape-scale disturbance variables (such as roads, railways, and oil and gas development) and densities of swans during the post-breeding surveys (J. Looft unpubl. data). In contrast, a study in Alaska demonstrated a negative relationship between transportation infrastructure and nesting lake occupancy (Schmidt et al. 2009).

Trumpeter swans can become accustomed to air traffic and small amounts of automobile traffic, even when the disturbance is relatively close to nesting areas (Holton 1982, Henson and Grant 1991, Varner 2008). However, loud traffic, human approaches and more severe disturbances can adversely affect breeding birds. When humans approach breeding lakes on foot, swans can be disturbed even from great distances; the mean response distance for a sample of swans breeding in the Grande Prairie area was greater than 700 m (J. Looft unpubl. data). These disturbances may cause nest failures or cygnet loss by disrupting feeding behaviour or causing females to take extended absences from the nest, exposing eggs to predation (Shea 1979, Henson and Grant 1991). Because trumpeter swans will not re-nest, clutch failure results in the loss of the breeding opportunity for an entire year (Grant 1991, Henson and Grant 1991). Moreover, in cases of severe disturbance, a pair may not return to the site in subsequent years (Brechtel

1982). Disturbance may also lead to reduced foraging rates or even premature departure from staging sites, as has been observed in southern Alberta (Hills 1996a).

Development near breeding wetlands in the Grande Prairie area has increased rates of disturbance, and may explain the absence of trumpeter swans from otherwise apparently suitable habitat. Industrial development can either result directly in disturbance, or create access corridors that allow for increased recreational use of breeding and staging habitat. Three previously productive lakes (Saskatoon, Wembley, and Crystal lakes) are now rarely used for breeding, probably because of both recreational use and adjacent intensive land-use (Brechtel 1982). In 2010, low water levels made Saskatoon Lake unsuitable for boating; trumpeter swans returned to the lake to breed for the first time in decades (ESRD 2013a), suggesting an adverse effect of disturbance there in most years. A recent breeding attempt at Crystal Lake, within the City of Grande Prairie, successfully hatched young but mortality of cygnets was high (R. Arbuckle pers. comm. in Alberta Trumpeter Swan Recovery Team 2006).

3. Water Management - Trumpeter swans prefer wetlands that are sufficiently shallow so that they can reach the bottom to forage, and their nest sites are often less than 50 cm above water level (Mitchell and Eicholz 2010). Consequently, increases in water levels can flood nests or foraging habitat, whereas reductions in levels can lead to wetland drying and loss of suitable habitat. In settled portions of the province, human use of water can lead to declines in water levels in natural wetlands. Irrigation of crops, watering livestock, withdrawing water to support oil and gas activities and other agricultural and industrial uses could all contribute to altered water levels, with effects on habitat quality for trumpeter swans. Natural alterations in water levels, from beavers and climatic variation, can also

have a profound influence on the suitability of trumpeter swan habitat.

4. Collisions with Power Transmission Lines, Fences and other Structures - Collision with power lines and other structures is a significant source of mortality for trumpeter swans in some regions (e.g., Whitman and Mitchell 2004), and is believed to be the largest source of anthropogenic mortality for swans in Alberta (Alberta Trumpeter Swan Recovery Team 2006). Mitchell and Eicholz (2010) indicate that collisions accounted for 18% of 436 swans found dead in Iowa, Wisconsin and Wyoming. In the Grande Prairie area, between 6 and 10 swan electrocutions are reported annually, and the actual number of deaths from electrocution may be much higher given that many incidents likely go unreported (D. Hervieux pers. comm. in Alberta Trumpeter Swan Recovery Team 2006). Collision mortalities have also been reported from the Pincher Creek and Cardston areas. Mortality appears to be greatest during spring migration (ESRD 2013a), but the full extent and population-level impacts of this mortality remain unknown. Biologists with ESRD have worked with power companies to explore mitigation options, such as burial of cables in areas where the risk of collision is greatest (ESRD 2013a).

5. Harvest and Accidental Mortality - Overexploitation through commercial hunting was a principal cause of the widespread declines in trumpeter swan numbers in the 19th century (Banko 1960, Monnie 1966, Brechtel 1982, Subcommittee on the Interior population of Trumpeter Swans 1997). Hunting of trumpeter swans was made illegal with the signing of the *Migratory Birds Convention Act* in Canada in 1917 and the *Migratory Bird Treaty Act* in the United States in 1918, and sport hunting remains illegal in Canada. Some poaching may occur in Alberta (e.g., a pair was shot in spring of 2003 near Grande Prairie; Alberta Trumpeter Swan Recovery Team 2006), but is assumed to be rare.

Tundra swans have been hunted in select states in the United States for a long time. Where species' ranges overlap, hunters may mistakenly shoot trumpeter swans given the difficulties in distinguishing the two species (Mackay 1981, Shandruk 1984, Drewien and Bouffard 1994). Tundra swan seasons have been in effect in the Pacific Flyway (Montana, Nevada and Utah) since 1962 and small numbers of trumpeter swans have been taken annually. In these three states in 1992, bill lengths of harvested swans reported by hunters suggested that 11 of 295 harvested swans were likely trumpeter swans (Drewien and Bouffard 1994). Subsequent data confirmed that trumpeter swans composed a small fraction of the hunt in Montana (19 of 890 swans harvested) and Utah (10 of 1 424 swans; Drewien et al. 1999). Montana, and North and South Dakota have held limited entry hunting seasons for tundra swans since 1983, North Carolina since 1984, and Virginia since 1988. These limited hunting seasons only authorize the take of tundra swans and have restrictions such as maximum numbers of permits and season dates and lengths to mitigate accidental harvest of trumpeter swans. In recent years, and as a result of restoration efforts for trumpeter swans in the Interior population, trumpeter swans have been present during fall and winter in Atlantic and Central Flyway states where tundra swan hunting is allowed but overall harvest of trumpeter swans remains very low. It is likely that migrating and wintering trumpeter swan numbers will increase in the Atlantic, Mississippi, and Central Flyways, leading to potentially conflicting management strategies in those states that currently allow tundra swan hunting. However, as long as trumpeter swan population management goals are maintained and appropriate mitigation strategies are implemented in the management of hunting seasons, it is expected that the continuance of tundra swan hunting in the United States poses a low risk to trumpeter swan populations generally (J. Caswell pers. comm.).

Lead poisoning has become less common since the use of lead shot for waterfowl hunting was banned in both Canada and the United States, but lead shot remains buried in the sediment and ongoing use of lead fishing tackle in many locations (although banned within National Parks in Canada and some National Wildlife Refuges in the United States) means that swans may still be exposed to harmful quantities of lead.

6. Limiting Factors Outside of Alberta – Shortage of Winter Habitat - A shortage of winter habitat has been considered a primary limiting factor for the Rocky Mountain population of trumpeter swans (Shea 1979, Mackay 1981, Brechtel 1982), based on the previous belief that nearly all of the Canadian flock wintered in a very limited portion of the Tri-State area (e.g., Barrett and Vyse 1982, Reisinger 1984, Alvo 1996, James 2000). Although the current fraction of the Canadian flock that uses these areas may be only approximately 60%, the area is still heavily used and water levels, weather and other features of habitat condition in this restricted area can play a critical role in the overwinter survival of Alberta's trumpeter swans. In 1984 and 1989, severe winter conditions caused the Snake River in Idaho to freeze resulting in the death of at least 50 and 100 swans, respectively (McKelvey et al. 1985). Competition for food and overcrowding may leave females in poor condition at the start of spring migration with carry-over effects on reproduction. Overcrowding and nutritional stress may also expose individuals to greater parasite burdens; for example, nasal leeches can further weaken adult birds and make them more susceptible to severe winter weather, or can kill cygnets outright (Drewien and Bouffard 1994).

Recent survey results suggest that the size of the Canadian flock exceeds the number of swans wintering in the Tri-State area by a substantial margin, suggesting that many (42% in 2010) Canadian-breeding birds must

now be wintering elsewhere. Although resighting studies have documented Canadian-breeding birds in a number of locations (see Distribution section above), the extent of the current wintering range is poorly known. This expanded wintering range may, in part, reflect the success of efforts that have been made to encourage dispersal to new wintering areas, through hazing (active attempts to frighten and disperse birds) and translocation. Additionally, the observation of large numbers of wintering trumpeter swans feeding on cull potatoes in fields in eastern Idaho is an indication of an expansion of wintering areas, and these new food sources may contribute to a reduced risk of winter mortality (R. Shea pers. comm.).

An increasing use of new wintering areas and food sources means that the risk of winter habitat shortage may be a less significant threat to the Canadian flock now than it was at the time of the previous status assessment (James 2000). However, a better understanding of the extent and condition of current wintering habitat is necessary in order to understand the degree to which this threat has been alleviated.

STATUS DESIGNATIONS⁴

1. Alberta - The trumpeter swan was listed as *Endangered* under Alberta's *Wildlife Act* in 1987. The species' listing was modified to *Threatened* in 1997. Following a status report in 2000 (James 2000) and a review of status in 2001, the listing of *Threatened* was maintained. The *Threatened* designation was based on the small population size in Alberta (fewer than 1000 mature individuals), continued dependence of the breeding population on habitats that are vulnerable to human disturbance and land-use activities, and continued concern about limited winter habitat (Fish and Wildlife Division 2004, ESRD 2013a).

⁴ See Appendix 1 for definitions of selected status designations.

Today, the species remains listed as *Threatened* and is classified as *At Risk* in the current *General Status of Alberta Wild Species* report (ESRD 2013b). A recovery team was established in 2003, and developed a recovery goal of "a self-sustaining trumpeter swan population, well distributed throughout suitable habitat within Alberta". A minister-approved recovery plan was produced in 2006, and an updated plan (with the same recovery goal) was approved in March 2013 by the Minister of Environment and Sustainable Resource Development (ESRD 2013a).

2. Other Areas - In 1978, COSEWIC listed the trumpeter swan as a species of *Special Concern*. Although swan numbers had increased from near extinction in the early 1900s, concerns still existed over low population levels and restricted distribution (Mackay 1978). By 1996, additional information about the expanding distribution and population of trumpeter swans (Alvo 1996) resulted in their status being changed to *Not at Risk*. The species has not been reassessed since this time.

The *Wild Species 2010: General Status of Species in Canada* considers trumpeter swans to be *Secure* in Canada. However, provincial status ranks vary: *Secure* in Ontario and British Columbia, *Sensitive* in Manitoba, Yukon and Northwest Territories, *May Be at Risk* in Saskatchewan and *At Risk* in Alberta (CESCC 2011). This assessment is unchanged from the 2005 report (CESCC 2006).

In the United States, the trumpeter swan was removed from the *Endangered* species list in 1968 following the 1954 discovery of the Pacific Coast population in Alaska (Erickson et al. 1969, King and Conant 1981). A petition to list the Rocky Mountain population as *Threatened* was filed in 1989 and denied in 1990 (Department of the Interior 1990). In 2000, another petition was filed to list the Tri-State breeding segment of the Rocky Mountain population as *Threatened*, but this request was

denied on the grounds that this segment was not a Discrete Population Unit (Department of the Interior 2003).

State-level ranks vary within the potential winter range of Alberta's trumpeter swans. The Wyoming Game and Fish Department ranks the trumpeter swan as NSS2, indicating a declining or restricted population in a vulnerable or declining habitat (Wyoming Natural Diversity Database 2012). Montana ranks the species as *Potentially at Risk* (Montana Natural Heritage Program 2012), Idaho ranks the breeding population as *Critically Imperiled* (S1) and the wintering population as *Imperiled* (S2; Idaho Fish and Game 2012), Nevada ranks the species as *Critically Imperiled* (S1; watchlist; Nevada Natural Heritage Program 2010) and Oregon ranks the breeding population as *Critically Imperiled* (S1) and the wintering population as *Apparently Secure* (S4; Oregon Natural Heritage Information Center 2007). Trumpeter swans are listed as a *Sensitive Species* by the Bureau of Land Management in Wyoming (USDI Bureau of Land Management 2001), and the USDA Forest Service in Region 2 (Colorado, Kansas, Nebraska, South Dakota, and most of Wyoming) and Region 4 (Idaho, Nevada, Utah, and western Wyoming; Travsky and Beauvais 2004).

Globally, the trumpeter swan has a heritage status rank of G4. In Canada, it is considered N4 (breeding) and N5 (non-breeding); similarly, it is N4 (breeding and non-breeding) in the United States (NatureServe 2013a).

RECENT MANAGEMENT AND RESEARCH IN ALBERTA

1. Elk Island National Park Trumpeter Swan Reintroduction - In 1987, staff from ESRD determined that human disturbance and habitat loss were threats to the long-term survival of the trumpeter swan in the Grande Prairie area. In response, Parks Canada, Canadian Wildlife Service, Friends of Elk Island National Park and

ESRD initiated a trumpeter swan reintroduction program. Mated pairs with young were translocated from Grande Prairie to Elk Island National Park, where there was ample available habitat and protection afforded by the National Park status. The dual purpose of the project was to re-establish a breeding population of trumpeter swans in Elk Island National Park and to establish an Alberta population that wintered on the Pacific Coast, where winter habitat was not limiting (Shandruk and Holton 1984). A secondary objective was to establish the population near a major population centre (i.e., Edmonton), to offer viewing opportunities for the public.

Young trumpeter swans often return to the area from which they fledged. Whereas the translocated adult birds returned to the Grande Prairie area in subsequent years, some of the cygnets that were moved to the park while young returned to the park or surrounding areas as subadults. In 1998, a pair of swans hatched and fledged four cygnets; the first successful fledging occurring in the park in over one hundred years (Beyersbergen and Kaye 2007). Translocations were suspended in 2001, and successful breeding has continued annually since that time (Elk Island National Park unpubl. data in ESRD 2013a). Surveys in 2009 counted 34 mature individuals returning to the area, with 16 settling within the park, 9 settling in Cooking Lake-Blackfoot Provincial Recreation Area to the south, 4 settling in the nearby Ministik Bird Sanctuary just east of Edmonton, and 5 settling on nearby private lands (Parks Canada unpubl. data). Thus, trumpeter swans are increasing in abundance and expanding their breeding distribution in the area. Swans released in Elk Island National Park have been observed in new wintering areas (see Distribution section above) and, although sightings of marked birds in winter are few (Beyersbergen and Kaye 2007), it appears that the project has also been successful in encouraging the expansion to new wintering areas.

2. Land-Use Guidelines - Alberta Environment and Sustainable Resource Development has developed a set of land-use guidelines to minimize disturbance to breeding trumpeter swans and encourage the ongoing recovery of the species in the province (Government of Alberta 2012). The focus of these guidelines is to protect the long-term integrity and productivity of breeding habitats, avoid direct disturbance of breeding birds, and minimize the creation of industrial access corridors that could result in secondary disturbance of breeding habitats through recreational use. The guidelines offer setback distances for development, industrial and agricultural activities, and are applied to known breeding lakes tracked in a provincial database. Since September 2012, proponents of oil and gas development projects are required to conform to these guidelines under the Enhanced Approvals Process. Similarly, forestry activities must conform to setback requirements through application of the Operating Ground Rules. However the land-use guidelines, while they appear to do an adequate job of protecting habitat integrity at known breeding wetlands, do not address maintenance of habitat for non-breeding pairs who are in the process of establishing pair and breeding site bonds, nor do they apply to potentially suitable habitat where evidence of breeding has not yet been recorded in provincial databases.

Protective notations for Crown land have also been used as a tool to restrict development activities in the vicinity of trumpeter swan breeding locations. To date, 84 195 acres (34 072 ha) of trumpeter swan habitat has been registered with a protective notation, and application for approval of another 156 287 acres (63 247 ha) of protective notation has been made in recent years (ESRD 2013a). In addition, nearly 2550 acres (1031 ha) of trumpeter swan habitat was permanently secured between 2000–2010 through the efforts of conservation organizations such as DUC, Alberta Fish and Game Association (AFGA), Nature Conservancy Canada (NCC),

and Alberta Conservation Association (ACA; ESRD 2013a).

3. Scientific Research - As populations of trumpeter swans have increased across the continent, scientific research has been carried out to estimate demographic rates, monitor habitat use and preferences, track and predict range expansion, monitor the genetic consequences of translocations and reintroductions, assess the prevalence and impacts of disease, and address a variety of questions important to management and conservation (see reviews in Mitchell and Eichholz 2010). Within Alberta, a research project has been conducted to understand the characteristics of ponds used by migrating trumpeter swans in spring, swans' nutritional needs and status at these sites, and the impacts of their increasing abundance on habitat condition (e.g., LaMontagne et al. 2003a, 2003b, LaMontagne et al. 2004). Another Alberta-based study developed models to quantify and map risk to waterfowl from collisions with power lines (Quinn et al. 2011). This has potential application to trumpeter swans, given the high rate of collisions observed for this species. Provincial biologists have also worked directly with power companies to explore mitigation options, such as burying lines near key staging lakes or flagging lines adjacent to swan lakes to make them more visible to swans (D. Stepnisky pers. comm.).

4. Public Education - Trumpeter swans are a charismatic species, and Environmental Non-governmental Organizations (e.g., the Trumpeter Swan Society) and the public have played important roles in monitoring the species' recovery and acting as stewards. Recognizing the value of public outreach, a trumpeter swan teaching unit for elementary schools was developed and published in 1999 (Alberta Environmental Protection and Canadian Heritage, Parks Canada 1999). The Alberta Conservation Association and Alberta Sustainable Resource Development also published an information leaflet describing the

species' status and threats in 2002 (ACA and ASRD 2002). More recently, ESRD released a "Guide for Landowners," which offers stewardship advice and best management practices to benefit swans (ESRD undated). Also, a Trumpeter Swan Festival is held at Saskatoon Island Provincial Park in April of each year; the festival attracts hundreds of participants and includes a variety of educational displays and bus tours to view swans.

SYNTHESIS

The trumpeter swan has made a remarkable recovery since the turn of the century, and continues to increase in abundance and regain some of its historically broad North American range. In Alberta, management efforts have supported substantial increases in both abundance and range, and the species now breeds widely across suitable habitat in several portions of the province. The Grande Prairie area continues to support a majority of the province's trumpeter swans, but numbers continue to increase away from this core range.

Despite the population increases, the trumpeter swan is still among the rarest waterfowl in North America. At least in northern portions of its Alberta range, availability of breeding habitat does not appear to be an important limiting factor. However, the species' sensitivity to disturbance means that it continues to benefit from land-use standards and guidelines where

breeding and human activities coincide. An unquantified threat is the high probability of human development activities around wetlands not currently used, but with suitable habitat for future breeding. The restricted network of staging habitats merits careful management to maintain habitat quantity and quality. A large fraction of the population winters in a restricted area of the Tri-State region, exposing it to effects of over-crowding and placing the population at risk of a localized, catastrophic event. However, Alberta's trumpeter swans may be making greater use of other wintering areas in recent years, reducing the magnitude of this threat since the time of the previous status assessment. A better understanding of the extent and condition of current wintering habitat is necessary in order to understand the degree to which this threat has been alleviated.

The ever-improving status of trumpeter swans in Alberta reflects the success of recovery efforts and the commitment of numerous stakeholders and partner agencies. Public interest in the species and awareness of the threats it faces has been cultivated through distribution of educational resources, and through outreach activities such as the annual trumpeter swan festival; continuing these activities could maintain public support for swan conservation in the province. Alberta is currently a stronghold for the Rocky Mountain population, and bears significant responsibility for the conservation of this international resource.

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Appendix 1. Definitions of status ranks and legal designations.

A. General Status of Alberta Wild Species Categories (used in 2000, 2005 and 2010 General Status exercises) (Alberta Environment and Sustainable Resource Development 2011)

Rank	Definitions
At Risk	Any species known to be <i>At Risk</i> after formal detailed status assessment and legal designation as <i>Endangered</i> or <i>Threatened</i> in Alberta.
May Be At Risk	Any species that may be at risk of extinction or extirpation, and is therefore a candidate for detailed risk assessment.
Sensitive	Any species that is not at risk of extinction or extirpation but may require special attention or protection to prevent it from becoming at risk.
Secure	Any species that is not <i>At Risk</i> , <i>May Be At Risk</i> or <i>Sensitive</i> .
Undetermined	Any species for which insufficient information, knowledge or data is available to reliably evaluate its general status.
Not Assessed	Any species that has not been examined during this exercise.
Exotic/Alien	Any species that has been introduced as a result of human activities.
Extirpated/Extinct	Any species no longer thought to be present in Alberta (Extirpated) or no longer believed to be present anywhere in the world (Extinct).
Accidental/Vagrant	Any species occurring infrequently and unpredictably in Alberta, i.e., outside its usual range.

B. Alberta Species at Risk Formal Status Designations

Species designated as *Endangered* under Alberta's *Wildlife Act* include those listed as *Endangered* or *Threatened* in the Wildlife Regulation (in bold).

Endangered	A species facing imminent extirpation or extinction.
Threatened	A species likely to become endangered if limiting factors are not reversed.
Species of Special Concern	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events.
Data Deficient	A species for which there is insufficient scientific information to support status designation.

C. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 2011)

Extinct	A species that no longer exists.
Extirpated	A species that no longer exists in the wild in Canada, but occurs elsewhere.
Endangered	A species facing imminent extirpation or extinction.
Threatened	A species that is likely to become endangered if nothing is done to reverse the factors leading to its extirpation or extinction.
Special Concern	A species that may become threatened or endangered because of a combination of biological characteristics and identified threats.
Not at Risk	A species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient	A category that applies when the available information is insufficient to (a) resolve a wildlife species' eligibility for assessment, or (b) permit an assessment of the wildlife species' risk of extinction.

D. United States Endangered Species Act (U.S. Fish & Wildlife Service 2005)

Endangered	Any species that is in danger of extinction throughout all or a significant portion of its range.
Threatened	Any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Appendix 1 continued:

E. Heritage Status Ranks:

Subnational (S) ranks in Alberta (after Alberta Conservation Information Management System 2013)

S1	Known from five or fewer occurrences or especially vulnerable to extirpation because of other factors.
S2	Known from 20 or fewer occurrences or vulnerable to extirpation because of other factors.
S3	Known from 100 or fewer occurrences, or somewhat vulnerable due to other factors, such as restricted range, relatively small population sizes, or other factors.
S4	Apparently secure. Taxon is uncommon but not rare. Potentially some cause for long-term concern because of declines or other factors.
S5	Secure. Taxon is common, widespread, and abundant.
SX	Taxon is believed to be extirpated from the province. Not located despite intensive searches of historical sites and other appropriate habitat. Virtually no likelihood that it will be rediscovered.
SH	Known from only historical records but still some hope of rediscovery. Evidence that the taxon may no longer be present but not enough to state this with certainty.
S?	Not yet ranked, or rank tentatively assigned.
S#S#	A numeric range rank is used to indicate any range of uncertainty about the status of the taxon. Example: S2S3 or S1S3. Ranges cannot skip more than two ranks.
SU	Taxon is currently unrankable because of a lack of information or substantially conflicting information. Example: native versus non-native status not resolved.
SNR	Not ranked. Conservation status not yet assessed.
SNA	Not applicable. A conservation status rank is not applicable because the species or ecosystem is not a suitable target for conservation activities. Example: introduced species.
S#?	Inexact numeric rank. Applied when a specific rank is most likely appropriate but for which some conflicting information or unresolved questions remain.

Global (G), National (N) and other Subnational (S) ranks (after NatureServe 2013b)

G1/N1/S1	Critically Imperiled. At very high risk of extinction or elimination due to very restricted range, very few populations or occurrences, very steep declines, very severe threats, or other factors.
G2/N2/S2	Imperiled. At high risk of extinction or elimination due to restricted range, few populations or occurrences, steep declines, severe threats, or other factors.
G3/N3/S3	Vulnerable. At moderate risk of extinction or elimination due to a fairly restricted range, relatively few populations or occurrences, recent and widespread declines, threats, or other factors.
G4/N4/S4	Apparently Secure. At fairly low risk of extinction or elimination due to an extensive range and/or many populations or occurrences, but with possible cause for some concern as a result of local recent declines, threats, or other factors.
G5/N5/S5	Secure. At very low risk of extinction or elimination due to a very extensive range, abundant populations or occurrences, and little to no concern from declines or threats.
GX/NX/SX	Presumed Extinct/Extirpated. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood of rediscovery.
GH/NH/SH	Possibly Extinct/Extirpated. Known from only historical occurrences but some hope of rediscovery.
G?/N?/S?	Inexact Numeric Rank. Denotes inexact numeric rank.
G#G#/ N#N#/S#S#	A numeric range rank (e.g., G2G3, G1G3) is used to indicate the range of uncertainty about the exact status of a taxon or ecosystem type. Ranges cannot skip more than two ranks.
GU/NU/SU	Unrankable. Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
GNR/NNR/ SNR	Unranked. Conservation status not yet assessed.
GNA/NA/ SNA	Not Applicable. A conservation status rank is not applicable because the species is not a suitable target for conservation activities.

Appendix 2. Technical Summary

A summary of information contained within this report, and used by the Scientific Subcommittee of Alberta's Endangered Species Conservation Committee for the purpose of status assessment based on International Union for Conservation of Nature criteria. For definitions of terms used in this technical summary, go to:

<http://www.iucnredlist.org/technical-documents/categories-and-criteria>, and

http://www.cosepac.gc.ca/eng/sct2/sct2_6_e.cfm

Genus species: *Cygnus buccinator*

Common name: Trumpeter Swan

Range of occurrence in Alberta: Trumpeter swans occupy approximately one-third of the province for breeding and are most abundant in the vicinity of Grande Prairie, northwest of Slave and Utikuma lakes, and west of Manning (Central Mixedwood, Dry Mixedwood, Lower Foothills, Peace River Parkland and Lower Boreal Highlands natural subregions). They are also found in parts of the Northern Mixedwood, Foothills Parkland, Foothills Fescue, and Lower Foothills natural subregions. Modern breeding records are absent from the Central Parkland, Dry Mixedgrass, Northern Fescue, Mixedgrass, Alpine, Subalpine and Montane natural subregions. A smaller number of different lakes are used for staging during spring and fall migration. These staging lakes are concentrated in the northwest and along the foothills area of the province.

Demographic Information

<p>Generation time (usually average age of parents in the population; indicate if another method of estimating generation time as indicated in the most recent IUCN guidelines is being used)</p> <p>See Population Size and Trends (Alberta), p. 14 [for estimated generation time] and Conservation Biology, p. 11 [for age of first breeding].</p> <p>Approximated with a life table method, using demographic rates from studies in Alberta and elsewhere.</p>	Approximately 10 years
<p>Is there an [observed, inferred, or projected] continuing decline in number of mature individuals?</p> <p>See Population Size and Trends (Alberta), pp. 12–16.</p> <p>The population is increasing.</p>	No

Appendix 2 continued:

<p>Estimated percent of continuing decline in total number of mature individuals within [5 years or 2 generations]</p> <p>See Population Size and Trends (Alberta), pp. 12–16.</p>	<p>Not applicable (population is increasing)</p>
<p>[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over the last [10 years, or 3 generations].</p> <p>See Population Size and Trends (Alberta), p. 14 and Figure 4, p. 15.</p> <p>Increase over 30 years (3 generations) was estimated from annual rate of population increase of 10.1%, which was calculated from the log-linear line of best fit over the 25-year period 1985–2010.</p>	<p>Nearly 18-fold increase over 30 years (3 generations)</p>
<p>[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [10 years, or 3 generations].</p> <p>See Population Size and Trends (Alberta), pp. 12–16.</p> <p>Large increases would be expected to continue for some time until available suitable habitat is full; there is not enough information on available habitat to determine when that would occur or by how much the population could increase over the next 30 years (3 generations). Winter mortality events as a result of large scale or extreme prolonged severe winter weather may reduce populations. These events cannot be reliably predicted.</p>	<p>Unknown, but likely large increase</p>

Appendix 2 continued:

<p>[Observed, estimated, inferred, or suspected] percent [reduction or increase] in total number of mature individuals over any [10-year, or 3-generation] period, over a time period including both the past and the future.</p> <p>See Population Size and Trends (Alberta), p. 14 and Figure 4, p. 15.</p> <p>Increase over 30 years (3 generations) was estimated from annual rate of population increase of 10.1%, which was calculated from the log-linear line of best fit over the 25-year period 1985–2010. It is reasonable to assume that this increase could continue for at least the next five years, making it possible to estimate that the population could be expected to increase by the amount given over the 30-year period from 1985–2015.</p>	<p>Nearly 18-fold increase over 30 years (3 generations)</p>
<p>Are the causes of the decline clearly reversible and understood and ceased?</p> <p>See Population Size and Trends (Alberta), pp. 12–16.</p>	<p>Not applicable (population is increasing)</p>
<p>Are there extreme fluctuations in number of mature individuals?</p> <p>See Population Size and Trends (Alberta), p. 14.</p> <p>Extreme fluctuations have not been observed in the long term, although there is potential for dramatic declines in population should large scale or extreme prolonged severe winter weather events occur on the species wintering grounds in the United States. These events cannot be reliably predicted.</p>	<p>No</p>

Extent and Occupancy Information

<p>Estimated extent of occurrence</p> <p>See Distribution (Alberta), pp. 4–5.</p> <p>Estimation is based on the minimum convex polygon (MCP) of sightings made only since 2000 during the breeding season, in provincial (FWMIS) and DUC databases. Given that suitable habitat (lakes, ponds and wetlands) is not continuous, the MCP approach overestimates the species' distribution in the province.</p>	<p>560 865 km² (equivalent to over 84% of the province's area)</p>
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Appendix 2 continued:

<p>Area of occupancy (AO) (Always report 2-km x 2-km grid value. An additional estimate of AO using a measure that is more biologically relevant to the species may be included)</p> <p>See Distribution (Alberta), p. 5.</p> <p>Based on sightings in the breeding season in FWMIS and Ducks Unlimited Canada databases. Not all potentially-suitable breeding habitat has been surveyed, and much remains to be learned about distribution during the migration periods.</p>	<p>4440 km² (based on 2x2 grid; only includes sightings made during the breeding season)</p> <p>>1576 km² based on area of mapped, occupied lakes (a known underestimate)</p>
<p>Is the total population severely fragmented?</p> <p>See Distribution (Alberta), pp. 2-5.</p> <p>Although the habitat is fragmented, swans can move freely within their range in the province.</p>	<p>No</p>
<p>Number of locations</p> <p>See Distribution (Alberta), p. 5.</p> <p>Nesting waterbodies can be considered separate locations because they are likely affected by threatening events independently. Smaller waterbodies typically support a single breeding pair. An earlier GIS model developed by the province in 2010 lists 914 discrete waterbodies where trumpeter swans are "present". The current number of locations is unknown, but likely larger.</p>	<p>>914</p>
<p>Is there an [observed, inferred, or projected] continuing decline in extent of occurrence?</p> <p>See Distribution (Alberta), pp. 2-5.</p>	<p>No</p>
<p>Is there an [observed, inferred, or projected] continuing decline in index of area of occupancy?</p> <p>See Distribution (Alberta), pp. 2-5.</p>	<p>No</p>

Appendix 2 continued:

<p>Is there an [observed, inferred, or projected] continuing decline in number of subpopulations?</p> <p>See Species Taxonomy, pp. 1–2 and Population Size and Trends (Alberta), pp. 12–16.</p> <p>No studies of subpopulation structure have been undertaken, but the overall population is increasing.</p>	No
<p>Is there an [observed, inferred, or projected] continuing decline in number of locations?</p> <p>See Distribution (Alberta), pp. 2–5.</p>	No
<p>Is there an [observed, inferred, or projected] continuing decline in [area, extent and/or quality] of habitat?</p> <p>See Habitat, pp. 7–10 and Limiting Factors (Loss of Breeding or Staging Habitat, Disturbance of Breeding Habitat), pp. 18–19.</p> <p>Concerns about declining habitat on staging wetlands have been documented; these concerns are related to the small size and limited number of wetlands supporting relatively high numbers of staging swans.</p>	Not to such an extent that it limits population growth, as evidenced by ongoing exponential increases in abundance
<p>Are there extreme fluctuations in number of subpopulations?</p> <p>See Population Size and Trends (Alberta), pp. 12–16 and Figure 4, p. 15.</p>	No
<p>Are there extreme fluctuations in number of locations?</p> <p>See Distribution (Alberta), pp. 2–5.</p>	No
<p>Are there extreme fluctuations in extent of occurrence?</p> <p>See Distribution (Alberta), pp. 2–5.</p>	No
<p>Are there extreme fluctuations in index of area of occupancy?</p> <p>See Distribution (Alberta), pp. 2–5.</p>	No

Appendix 2 continued:

Number of Mature Individuals (in each population)

Population	N Mature Individuals
Estimated number of white swans (one year of age and older) from 2010 survey (the population has increased since then).	2829 ± 390
Estimated proportion of white swans that are mature individuals (assumed here to mean four years of age and older): 61% of white swans.	>1700 (1500–2000)
Estimated number of adults that breed in a given year, based on 20%–30% of mature population (likely an underestimate).	566–849 (95% CI: 488–966)
Number of broods directly observed in 2010 (279) x 2 adults/brood (= minimum # adults)	558
Estimated breeding population based on brood counts in 2010, extrapolated across sampling frame (993) and taking into account nests or broods lost prior to surveys (1433)	993–1433
Total	
See Population Size and Trends (Alberta), pp. 12–16.	
The number of mature individuals is derived from applying the estimated proportion of mature white swans to the 2010 population estimate. This number has probably increased since 2010; if it continued to increase at the same annual rate that it has increased by over the last 42 years (11.6% per year), the 2012 population could be over 2000 mature individuals.	>1700 (1500–2000) mature individuals

Quantitative Analysis

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Analysis not undertaken
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Appendix 2 continued:

Threats (actual or imminent, to populations or habitats)

Current threats include:

- Loss of breeding or staging habitat
- Disturbance of breeding habitat
- Water management
- Collisions with power transmission lines, fences and other structures
- Poaching or accidental shooting
- Severe weather and shortage of winter habitat outside of Alberta

See Limiting Factors, pp. 18–21.

Rescue Effect (immigration from outside Alberta)

Status of outside population(s)?

See Population Size and Trends (Other Areas), pp. 16–17.

North American populations have increased substantially in recent decades, and are expanding in some areas.

Is immigration known or possible?

See Species Taxonomy, p. 1–2 and Population Size and Trends (Rescue Potential), pp. 17–18.

The distribution of the Rocky Mountain population of trumpeter swans extends into British Columbia, the Northwest Territories and the Yukon. Trumpeter swans are mobile and immigration into Alberta from these areas would be possible.

Yes

Would immigrants be adapted to survive in Alberta?

See Introduction, p. 1, Population Size and Trends (Rescue Potential), pp. 17–18 and Recent Management and Research, pp. 22–23.

Successful translocations across the continent suggest that trumpeter swans are able to survive in the variety of conditions encountered throughout their broad range.

Yes

Appendix 2 continued:

<p>Is there sufficient habitat for immigrants in Alberta?</p> <p>See Distribution (Alberta), pp. 2–5, Habitat, pp. 7–10 and Population Size and Trends (Rescue Potential), pp. 17–18.</p> <p>There appears to be suitable, unoccupied habitat in northern Alberta.</p>	<p>Yes</p>
<p>Is rescue from outside populations likely?</p> <p>See Figure 1, p. 2, Species Taxonomy, pp. 1–2 and Population Size and Trends (Rescue Potential), pp. 17–18.</p> <p>Trumpeter swans are mobile and there are healthy populations in adjacent jurisdictions but, despite evidence of occasional mixing among North American populations, they do not appear to have naturally recolonized suitable habitat in Alberta. Recolonization is possible, but will take a relatively long time. In the shorter term, movement of swans into areas that are separated from currently-occupied habitat will likely require direct management action (e.g., the transplant program at Elk Island National Park). Areas contiguous to occupied habitat could see immigration from adjacent populations, but not likely from jurisdictions outside of Alberta.</p>	<p>Yes – long term</p>

Appendix 2 continued:

Current Status (See Status Designations, pp. 21–22)

Provincial: *Threatened*

National: Not at Risk

Elsewhere:

- British Columbia and Ontario: Secure
- Manitoba Yukon and Northwest Territories: Sensitive
- Saskatchewan: May be at Risk
- Global heritage rank: G4
- National conservation status for the species in
 - Canada: N4 (breeding); N5 (non-breeding)
 - United States: N4 (breeding and non-breeding)
- United States: removed from *Endangered* list in 1968
- State rankings
 - S1: Idaho (breeding), Nevada, Oregon (breeding)
 - S2: Idaho (non-breeding)
 - S3: Montana
 - S4: Oregon (non-breeding)
 - Potentially at risk: Montana
- Listed as a *Sensitive Species* by the Bureau of Land Management in Wyoming, the USDA Forest Service in Region 2 (Colorado, Kansas, Nebraska, South Dakota, and most of Wyoming) and Region 4 (Nevada, Utah, Idaho, and western Wyoming).
- Ranked as NSS2 (declining or restricted population in a vulnerable or declining habitat) by the Wyoming Game and Fish Department.

Author of Technical Summary: Robin Gutsell

List of Titles in This Series
(as of August 2013)

- No. 1 Status of the Piping Plover (*Charadrius melodus*) in Alberta, by David R. C. Prescott. 19 pp. (1997)
- No. 2 Status of the Wolverine (*Gulo gulo*) in Alberta, by Stephen Petersen. 17 pp. (1997)
- No. 3 Status of the Northern Long-eared Bat (*Myotis septentrionalis*) in Alberta, by M. Carolina Caceres and M. J. Pybus. 19 pp. (1997)
- No. 3 Update 2009. Status of the Northern Myotis (*Myotis septentrionalis*) in Alberta. Alberta Sustainable Resource Development and Alberta Conservation Association. 34 pp. (2009)
- No. 4 Status of the Ord's Kangaroo Rat (*Dipodomys ordii*) in Alberta, by David L. Gummer. 16 pp. (1997)
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- No. 6 Status of the Prairie Rattlesnake (*Crotalus viridis viridis*) in Alberta, by Sheri M. Watson and Anthony P. Russell. 26 pp. (1997)
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